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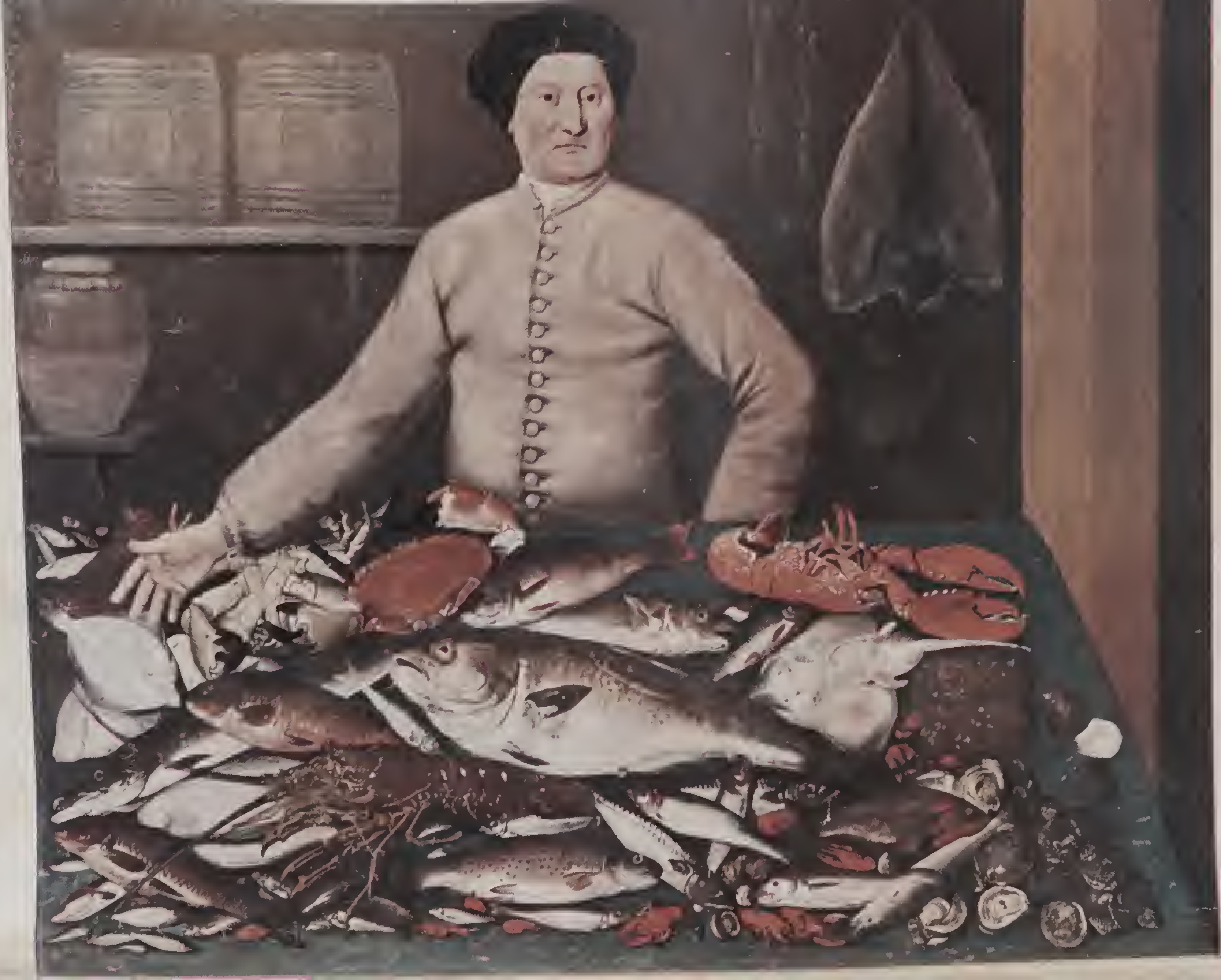

PLATE I.—The Fish Merchant. Sometimes ascribed to Hogarth, but probably by Joseph van Aken (d. 1739).

By courtesy of the Clerk to the Worshipful Company of Fishmongers London.

FISH SAVING

A HISTORY OF FISH PROCESSING
FROM ANCIENT TO MODERN TIMES

by

Charles L. Cutting, B.Sc., Ph.D., F.R.I.C.

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SAVE: to store, preserve, keep in sound condition.

1601 Holland, *Pliny II*, 507, 'After that it ought to be dried in the sun, and saued in a brasen box.'

1602 Carew, *Cornwall* (1723), 33, 'They (the Fish, i.e. pilchards) are saued by three maner of wayes: by fuming, pressing or pickelling.'

1729 Pope, *Dunciad*, I, 151, 'There sav'd by spice like mummies, many a year, Dry Bodies of Divinity appear.'

To remain in good condition, to last without spoiling, to 'keep'.

To be capable of preservation: said of fish: as, to *save* well.

(*New English Dictionary*)

'Great abilities,' said he, 'are not requisite for an historian; for in historical composition all the greatest powers of the human mind are quiescent. He has the facts ready to his hand; so there is no exercise of invention. Imagination is not required in any high degree; only about as much as is used in the lower kinds of poetry. Some penetration, accuracy, and colouring, will fit a man for the task, if he can give the application which is necessary.'

(*The Life of Samuel Johnson, LL.D.*, by James Boswell, 1791)

'He who writes, may write for once as I do.'

(From *One Word More* by Robert Browning)

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PREFACE

History is, or ought to be, a science, with a discipline and technique of research which, no doubt, has to be learnt like that of any other subject. On this basis, the following chronicle of the methods evolved by man down the ages for keeping fish in edible condition cannot be regarded as a work of scholarship. It is merely based on data collected in spare-time reading against a background of specialist knowledge acquired by work in the field of fisheries technology. Although this study does not claim to be complete or original in treatment, similar essays in the past have been much more limited in scope and chiefly the work of historians without the technological background. Moreover, much of the material collected together here is rather scattered and inaccessible to the general reader with an interest in fish; to him this book may appeal.

An appreciation of the historical perspective of a subject is useful in assessing future trends and possibilities. In particular, a study of the developments of the past is a salutary corrective to the discouraging attitude that 'as things have been they remain'. Our grandfathers were pioneers who would have repudiated such an outlook.

This work concentrates on the techniques of preserving fish as food. The technicalities of catching fish and fishery statistics as such have been avoided, except when they have a bearing on the main subject. Inevitably the emphasis has been placed mostly on the experience of the English-speaking world. However, until the standard history of fish technology comes to be written by a combination of historian and fish technologist, it is hoped that this attempt may be of general interest as one important aspect of man's continuous campaign against nature for his material necessities.

Humber Laboratory, Hull,
Food Investigation Organisation
Department of Scientific and Industrial Research.

March, 1954.

INTRODUCTION

Food even more than clothing or shelter is the indispensable necessity of mankind. The history of our species is largely an account of the evolution of equipment and methods of hunting, gathering, cultivating, breeding and otherwise controlling food supplies. Although the initial production of food is primary, the methods adopted for its preservation, storage and distribution, are no less important and react on the former.

In all periods and at all levels of technological progress, fish has usually played an essential part in man's diet. Although there are occasionally communities that do not eat fish, whether for reasons of geography or tabu, far more people throughout the world have been and still are dependent almost entirely on fish than is the case with meat.

Fish, however, is more susceptible to spoilage than certain other animal protein foods, such as meat and eggs. As part of the natural process by which organic matter is broken down and returned to the nitrogen cycle, fish flesh is rapidly invaded, digested and spoiled by the micro-organisms which are abundant on the skin and in the intestines. Ferments ('enzymes' to the scientist) also contribute to the dissolution, and oxidation by atmospheric oxygen is an additional process of deterioration, particularly in the case of natural fats.

As a result, methods of preservation to counteract these processes must in former days have been essential to the utilization of fish as food. Fish in early times occupied a key position as one of the most easily accessible sources of protein food; and the spread of man himself was probably determined by the success of the techniques of preservation and storage employed.

The principal processes employed to check bacterial and other forms of spoilage have been few in number. 'Curing'* by drying, smoking, and salting with common salt, in various combinations, is bacteriostatic or bactericidal in varying degree. Other salts, acids such as vinegar, sugar, and certain spices and herbs, have a similar effect. Even fermentation itself can be a

---

* *Cure*: preserve (meat, fruit, tobacco) by salting, drying, etc. (from Latin *curare* 'to take care of')—*Concise Oxford Dictionary.*

B

means of preservation if the process of decomposition is properly controlled. Cooling by means of ice slows down the multiplication of micro-organisms and hard-freezing below a certain temperature suspends it altogether. Canning results in their destruction by heat.

These processes, which are all in use to-day, have their characteristic problems and limitations. Furthermore, a certain level of technique, and of social organization, was required in each case before material circumstances permitted its appearance in history (*see* Table I, p. 12).

In a few cases it has been claimed by historians that the techniques of fish preservation have not been without their effect on history. Thus the development in the Low Countries of improved methods of salting herring in the fifteenth century is said to have 'changed the course of history'.[1] At least it permitted the economic and maritime development of the Netherlands which finally led to their throwing off the Spanish yoke. Similarly, the dried salt cod produced off Newfoundland soon after its discovery, possessed such excellent storage properties that doubt has been expressed whether, without it, the exploration of Tudor times would have been possible.[2] Again, canning was brought into existence during a war, and has always thrived on wars, and in fact it would be difficult to imagine that modern warfare would have been possible without canned foods. Dehydration has yet to justify its claim to a share in this responsibility as far as fish is concerned.

From the archaeological and written records, the main trends can be followed with some precision. Information about ancient and prehistoric practices is inevitably sparse and scanty, although they may have continued virtually unchanged for many hundreds or even thousands of years. On the other hand, many developments since the beginning of the industrial era are fully documented with names and dates. In addition, the pace of technological advance has greatly accelerated, so that there is more to write about in recent times.

By the Middle Ages, it is possible to distinguish, amid numerous variants, that certain methods of treatment possessed definite advantages in a given technological, geographical and social environment. Special processing patterns became fixed over comparatively long periods of time. Thus, in the North Atlantic countries, methods of salting and drying, whether combined (as in salt cod, etc.), with smoking (as in 'red herrings'), or alone (as in salt pickled herring and wind-dried cod—'stockfish'), have persisted practically unchanged for at least five hundred years.

The methods used are, of course, limited by natural conditions. For example, biological and physical factors have often been largely beyond man's control. There are often interesting minor local variations by which a process is adapted to geographical and climatic environment. This appears to account for differences between the cures of dried and salted cod, produced in various areas.

France was suitably placed for the production of 'solar' salt by the natural evaporation of sea-water in the marshes of her south-west coast. She therefore relied primarily on salting rather than drying for her Newfoundland fishery. The Norwegians and Icelanders with a cold, bright climate and a rocky coast, were able to develop a cure of stockfish by drying without salting. The English in their Iceland 'stockfishery' apparently used some salt. Being always short of salt, they combined in Newfoundland, where drying conditions were not as good, their previous experience of drying, together with the use of the smallest possible quantity of salt for all except the largest fish. The large fish caught off New England could be dried fairly easily during its more favourable winter. The Canadian climate was less ideal. In Nova Scotia, where adequate supplies of salt could be obtained because of extensive trading with the West Indies, the characteristic product was much more heavily salted than the Newfoundland cure. On the Gaspé coast, however, salt was scarce and, on account of the climate, great skill was required to pit the minimal salt content against spoilage in a distinctively flavoured cure, which is rather difficult to produce. Farther north still, along the Labrador coast, drying conditions were much less suitable and the cure was moister. The same applies to the north-west coast of Newfoundland, whither the French were forced by the English. The principal types of cure, originally evolved to meet local necessities, persist to this day. Broadly speaking, the traditional combinations of processes which optimally resist the forces of decomposition, survive until the economic and technical background which produced them is superseded by a higher form of organization.

Numerous examples in the following chapters show that when a certain threshold is reached, the old techniques are often rapidly replaced over a relatively short period by new ones which conform more closely with the new conditions. For instance, the popular consumption of heavily salted fish in Britain decreased quite sharply in the middle of last century, chiefly because the railway network then under construction permitted for the first time large-scale, wide-spread, inland distribution of fish in the much more attractive, fresh state. By presenting fish in a more appetizing form, 'freshing' altered the popular attitude towards it, and this was one reason for the vast increase in demand which occurred during the succeeding century.

If the literary allusions of Shakespeare and others can be relied upon, preserved fish was held rather low in popular esteem in the sixteenth century; nevertheless, most people had to be content with the food that was generally available. At this period, England was better known for its salt fish than for its roast beef. A much quoted passage of 1542 tells us that 'of all nacyons and countres, England is best served of Fysshe, not only of al maner of see-fysshe, but also of fresshe-water fysshe, and of all maner of sortes of salte-fysshe.'[3]*

Whereas in the sixteenth century, even the children of the well-to-do (e.g. in the Percy household), customarily ate salt fish, by 1753 Dr. S. Nelson could say in *An Essay on the Government of Children*[5] that 'Fish is a sort of Diet extremely improper for Children. I would recommend to Parents never to let a Child so much as taste it for the first seven years at least.'

Similarly, it was possible to get exemption from the obligation to eat fish instead of flesh in Lent, as appears from the following entry for 1619, 'I, James Fludd, Doctor in Divinity, and parson of the church of St. Marie Newington, in Surrey, do give licence unto Mrs. Ann Jones, of Newington, being notoriously sicke to eat flesh this time of Lent, during the time of sickness *onlye*.' At that time fish was not therefore regarded as the delicate food, highly suitable for invalids, that it is to-day. This is understandable since fish in the traditionally salted and dried forms as one writer complains, 'are left in a condition that demands the greatest efforts by the stomach to extract the food value from the fibrous masses.'[6] And fish in the unpreserved state was all too often justifiably suspect.

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* But Andrew Boorde was perhaps rather free with superlatives in his *Dyetary of Helth*, because he also claims that 'in all the world there is no region or country that doth use more swearing than is used in England.'[4]

Nicolas Appert, who in 1810 won a prize of 12,000 francs for his invention of preservation by heating in closed containers (later known as canning), summed up the objections to the effects on palatability of the processes then available, of which those that applied to fish were that desiccation took away the odour, changed the taste of the juices and hardened the fibres, while salt communicated an unpleasant acerbity, hardened the fibre, and made it indigestible.[7]

In this connexion, another lesson that can perhaps be drawn is that only when a certain social and technological level is attained can a need be fulfilled or a discovery usefully exploited. Thus it might be said that the technical basis for preservation by canning had been in existence since Papin invented the pressure cooker in 1681.* However, its appearance in 1810 as a result of a public competition was the direct and conscious outcome of the Napoleonic period of warfare with large, citizen armies. Canned foods provided a much needed alternative to the 'hard-tack' on which soldiers and sailors—even more than civilians—had previously subsisted without enthusiasm and with notorious nutritional deficiences, particularly that resulting in scurvy. At one time it was thought that the diseases resulting from a diet consisting of salt foods were due to the salt as such, but we now know the reason to be that certain, essential, accessory, dietary factors (vitamins) are destroyed as a result of the long and severe treatment foods undergo during salting and drying: canning resulted in a much greater retention of these substances. For its large-scale development, canning required steam, iron boilers, tinplate, complicated machinery and the factory system, all of which were part and parcel of the industrial era.

Canning did not begin to play a great part commercially until about the the eighteen-eighties, and its large-scale development has been contemporaneous with the emergence of a world consumer market for imported foods in the late nineteenth and early twentieth centuries. Since this market is by no means satisfied as yet, it seems likely that canning will reach even greater heights in the not too distant future.

---

* John Evelyn, the diarist, wrote on 12th April, 1682: 'I went this afternoon with several of the Royal Society to a supper which was all dressed, both fish and flesh, in Monsieur Papin's digestors . . . We eat pike and other fish bones, and all without impediment . . . This philosophical supper caused much mirth amongst us.'[8]

Industrialization was accompanied by a rapid rise in the population. The estimated number of people in Britain in 1750 was about 6½ millions, which was probably only about 50 per cent more than two centuries earlier. By 1840 the number had quadrupled and by 1910 had nearly doubled again. This manufacturing population had to be fed and a vast increase in fish supplies in this period was produced by the development of trawling, which was more efficient than hook and line, combined with icing and railways and finally steam trawling, which permitted exploitation of the biologically more prolific grounds in the Arctic.

The course of internal development of a procedure within given social and technological limitations, can be clearly seen in this period which includes the present. While fish was caught close to the shore it could normally be brought to land as it was. Once inshore grounds were exhausted the range of fishing vessels was extended, and special measures, such as gutting and icing, had to be adopted to keep the fish fresh during the voyage home. At the same time, icing eliminated a bottleneck in preservation, thus opening up the way for quantitative and qualitative improvements in fishing technique, by permitting a further extension of the voyage, an expanded fishing area, and therefore increased landings. The element of uncertainty attached to returning to port in a sailing ship with a perishable cargo led to the application of steam to the fishing vessel, which also resulted in improved fishing methods. This again led to increased catching capacity with still further extension of the tether. However, the natural limitations of ice as a preservative are a barrier to the indefinite extension of the operations of the distant water trawling industry. This technical impasse calls for a further leap forward, in this case, probably freezing at sea, which will be as radical a departure from current practice as icing at sea was a hundred years ago.

At the same time the rôle of the individual in determining history should not be overestimated. Not only must the social and economic environment of an invention prove suitable before it can take root, but in addition every man builds on the work of his predecessors. George Sarton, the historian of science, in discussing William Beukel's reputed fifteenth century discovery of herring pickling, points out that: 'An invention is seldom final, but rather a link in an endless series. Each link has its own origin, its own story: it is always difficult, and sometimes impossible to weigh its relative importance.'[9] (*See* p. 60).

Sometimes, no obvious single reason can be adduced to account for the survival value of certain competing techniques and the elimination of others. One such example is the various patterns of mild smoke curing that have developed during the industrial era. The British adopted 'cold-smoked' products such as the 'kippered' herring and 'finnan' haddock, to the almost total exclusion of 'hot-smoked' products, cooked in the kiln, which are represented to-day only by such a local survival as the Arbroath 'smokie' (*see* p. 282). On the other hand, over most of northern Europe, there is a much greater preference for such products as the *Bückling*, a hot-smoked herring, and eels treated in the same way.

> Turn we this Globe; and let us see
> How diff'rent nations disagree,
> In what we wear, or eat and drink . . .

said Matthew Prior (died 1721) in *Alma, or the Progress of the Mind*. 'One man's meat is another man's poison' is an adage equally true of fish. Dr. Samuel Johnson, referring to the natural repugnance to eating eels felt by the 'vulgar inhabitants of Sky', as he calls them, remarks: 'It is not very easy to fix the principles upon which mankind have agreed to eat some animals and reject others; and as the principle is not evident, it is not uniform. That which is selected as delicate by one country, is by its neighbours, abhorred as loathsome.'[10]

The importance of habit in conserving a particular pattern of processing once it has been established, must not be overlooked, but neither should it be exaggerated. Habits can be overthrown by necessity or by the offer of a more attractive or more plentiful and cheaper alternative. Thus, fresh-water fish, including 'coarse' fish, not so very long ago was an expensive luxury for most people in Britain. It is still much eaten in countries far from the sea, such as Czechoslovakia, or those with numerous lakes, such as Finland and Canada, or others, such as China, where conditions are favourable for 'pisciculture' in ponds. Yet to-day, many people in Britain would regard, say a tench, with as much suspicion, if not revulsion, as they would horse or goat flesh, even although it might well make better eating than a staleish haddock, for example. The reason for this change of attitude is, presumably, that in the course of the past century our fish-eating habits have been largely conditioned by the availability of plentiful supplies of trawled sea fish. Similarly, only a hundred years ago, halibut was despised as a food fish: they were certainly regarded as a nuisance by the cod fishermen of Shetland, France and New England, because they could not be salted and dried as a generally acceptable article of commerce. Boswell in 1762 overheard a citizen in Child's coffee-house ask: 'What is the reason that a sole is not a good fish?'* Even at a later period when fish were landed alive by the fishing vessel, it was cod that was the species principally sought after for sale, along with plaice, to the well-to-do. On the other hand, only a little later, the early trawlers jettisoned most of their haddock and plaice as 'offal fish' in preference for 'prime fish' which now included halibut, cod, and John Dory. Now that cod is by far the most numerous species landed from distant waters, practically any species of flat-fish commands a higher price, and it is a far cry to 1883, when, according to a writer, plaice was looked upon as a 'cheap and wholesome food' for 'the poorer classes in London and the large manufacturing towns.'[12]

A similar reversion of esteem related to the availability of supplies seems to have occurred within recent times in the case of oysters, which must have been rather low-class provender in Dickens's day, to judge from Sam Weller's remarks on their association with poverty. Pickled salmon is mentioned in the same connexion. There are also many stories of salmon being so plentiful as to arouse protests from work-people served with them too often by their employers. However, Drummond remained unconvinced of this when all reliable contemporary evidence indicated that salmon has always been a high-priced article.[3]

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* The reply had a strongly personal flavour: 'Why, it is a good fish if you dress it with a plain butter sauce. But you must have something so dev'lish high-seasoned. You might as well have a sauce of fire and brimstone.'[11]

To take another example from quite a different area; although native tastes in Africa are supposed to be particularly conservative, Norwegian stockfish, which was first imported about 1912, was soon accepted into the diet and is still in great demand in Nigeria. In the same way, too, much earlier, the heavily smoked and salted 'red herring' must have been introduced into the Mediterranean countries and the Levant, where it has now been established for some centuries.

The conclusion of history on habits, therefore, seems to be not so much *de gustibus non est disputandum* as *mutatis mutandis*.

A further factor which has emerged in the last sixty years is the growth of consciously applied research into the technology of fish preservation. Needless to say, before the growth of modern science, men's ideas of the basic reasons underlying what they did to counteract spoilage by various methods of preservation were mostly erroneous and frequently couched in semi-mystical terminology of a type which is still to be met with in the older processes. It is only since Pasteur's elucidation of the nature and function of micro-organisms that the process of food spoilage and therefore the *raison d'être* of preservation has been understood. The famous Second Law of Thermodynamics was originally deduced by Carnot on the basis of the totally erroneous concept of 'heat-substance', or 'caloric'; and Priestley, the early chemist, accepted without question the assumption of 'phlogiston', with its negative weight. In this context, the misconceptions of the early days of canning are not surprising. The commonest belief, subscribed to, for example, by so eminent a chemist as Gay-Lussac, was that the oxygen in air was in itself inimical to preservation.[13]

Not until 1896 did Prescott and Underwood—followed in 1897 by McPhail working on the difficulties encountered with the Canadian canned lobster pack—demonstrate to canners that the most important factor was the destruction by thorough heating of all contaminating micro-organisms, whether naturally occurring, airborne, or carried by human beings. The reason for 'keeping the air out' by means of hermetically sealed containers was to prevent subsequent re-infection of the sterilized product by the floating micro-organisms that air invariably contains. More recently, the realization that viable spores can resist normal sterilization treatment has revealed that even this picture is an over-simplification.

Although since the end of the nineteenth century various private and government-financed institutions throughout the world had been devoting considerable attention to the biological problems of fish and fisheries, until about twenty-five years ago relatively little organized effort was directed to elucidating the scientific facts underlying the practical aspects of the preservation of fish as food. Owing perhaps partly to the technical backwardness of the fish industry and the relatively simple, in fact primitive, nature of its basic processes of preservation and distribution, the awareness of the importance of the application of science was rather late in developing. In fact, it has been the economic difficulties of the fishing industry that have stimulated interest in the possibility of consciously planned technical advance opened up by scientific research. Moreover, it was scientists and administrators, rather than industrialists, who saw the need for such an application of science and encouraged it. As a result, by far the greater proportion of the research which has hitherto been carried out in this field has been financed by the expenditure of governments.

So far as the British Empire is concerned, the Imperial Economic Committee's Report on Fish in 1927[14] stated that: 'We believe that the first essential, the *sine qua non*, for all improvement of organization lies in the study and application of better methods of preserving fish at an economic cost.

'So we reach our principal recommendation, which is, that research should be instituted with a view to improving the methods of preserving fish from the moment when it has been caught to the moment when it reaches the consumer.

'We think that this Research should be based on (*a*) a Central Station at a fishery port in Great Britain; (*b*) a specially constructed vessel.'

At that time the Fisheries Department of the Government of Canada had already set up such a station for the Maritime Provinces at Halifax, in Nova Scotia. Soon afterwards, in 1929, the Food Investigation Board of the U.K. Department of Scientific and Industrial Research, established a similar research station at Torry, a suburb of Aberdeen in Scotland. A further Canadian Fisheries Experimental Station was also inaugurated at Prince Rupert, in British Columbia, from which it was subsequently transferred to Vancouver. With regard to the 'specially constructed vessel' mentioned above, up to the present a modified trawler has sufficed for the supply of fish required for the research programme. However, this vessel will soon be replaced by a new trawler at present (1954) under construction. This will have a long range, large fish-hold, great manœuvreability, and be capable of most types of fishing as well as carrying experimental equipment for freezing at sea.

In the past quarter of a century, the scientific workers at these and similar government institutions in others of the more advanced countries, including particularly U.S.A. and Norway, have obtained a considerable insight into the factors involved in the preservation of fish and as a result have, in many cases, been able to advise industry on problems concerned with most of the methods of preservation already discussed. In some cases they have been able to lead industry into new developments, on sounder lines, probably, than they would have arrived at on their own, e.g. in establishing the need for really low temperatures of storage, in the region of –20° F., for frozen fish; and in recommending practicable but sound designs of mechanical fish-smoking kilns. Refrigeration and cold storage of fish is, in fact, a case in which the issues involved are to some extent beyond the experience and capacity of the 'practical man' although it is true that a measure of success was achieved empirically. Our understanding of the principles underlying the successful freezing of fish has benefited by a marriage of the two rather widely divergent disciplines of refrigeration engineering and the biochemistry of once-living tissue. Canning, by comparison, was able to develop fairly satisfactorily in the first place on a 'hit-and-miss' basis, supplemented by skilful cookery and thoroughgoing mechanization which, however elaborate, is little removed from 'gadgeteering'.

Here again, however, the problems of heat penetration, in relation to the bacteriological aspect already mentioned, and of corrosion of tin-plate, for example, ultimately necessitated a more fundamental understanding of the physics and chemistry of the processes involved.

Research is never finished and, as the industry develops, more

TABLE I

Historical Development of Methods of Preserving Fish (With Particular Reference to Britain)

Technological Level	*Characteristic Fishing Implements*	*Characteristic Preservation Techniques and Features*	
Palaeolithic	Bone harpoons	Drying; cooking	
Neolithic	Improved harpoons; bone hooks; boats	Do.; do; smoking	
		Fatty Fish	*Non-Fatty Fish*
Bronze Age	Copper and bronze fish-hooks; nets	Salt pickling.	Salting and drying; smoking
		Trade	
Iron Age	Iron hooks, etc.; increased use of ships	Use of salt increasing; extensive trade.	
Feudalism	Mill weirs; 'stews'; hand-lines; drift-nets; 'busses' ; 'doggers'	Improved methods of salting (pickled, or 'white', herring), and smoking ('red' herring)	Drying (stock-fish), salting and drying (salt fish); voyages to Iceland and Newfoundland
Industrial Era			
Early Period	Trawling; lining; live fish vessels	Land carriages	
Middle Period	Sailing beam trawler: sailing drifter. Steam capstans and winches	Transport in ice and salt on fast sailing smack or steamer	Gutting and icing at sea; 'well-vessels'; 'fleeting'
		Railways and use of ice during transport	
Later Period	Steam trawlers; steam drifters; seine-netting and ring-netting. Constant improvements in fishing gear and increase in size of trawlers; echo-sounders; radar	Mild smoking (kippers, bloaters and buckling); canning; fish meal and oil	Mild smoking (finnan haddocks); freezing and cold storage on land. Distant fishing grounds
		Enormous increase in supplies	
The Future	Fish farming; fertilization of the sea; underwater television; electrical attraction of fish?	Icing at sea. Freezing and cold storage on shore. Larger scale canning and dehydration	Large scale freezing at sea and cold storage on shore.
		Electronic sterilization?	

problems requiring solution are being continually thrown up. Fish technological research stations are now becoming as much a part of the established order of things as fish biological stations and few nations are now without some organization for carrying out scientific work in this field.

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Chapter 1

ANTIQUITY

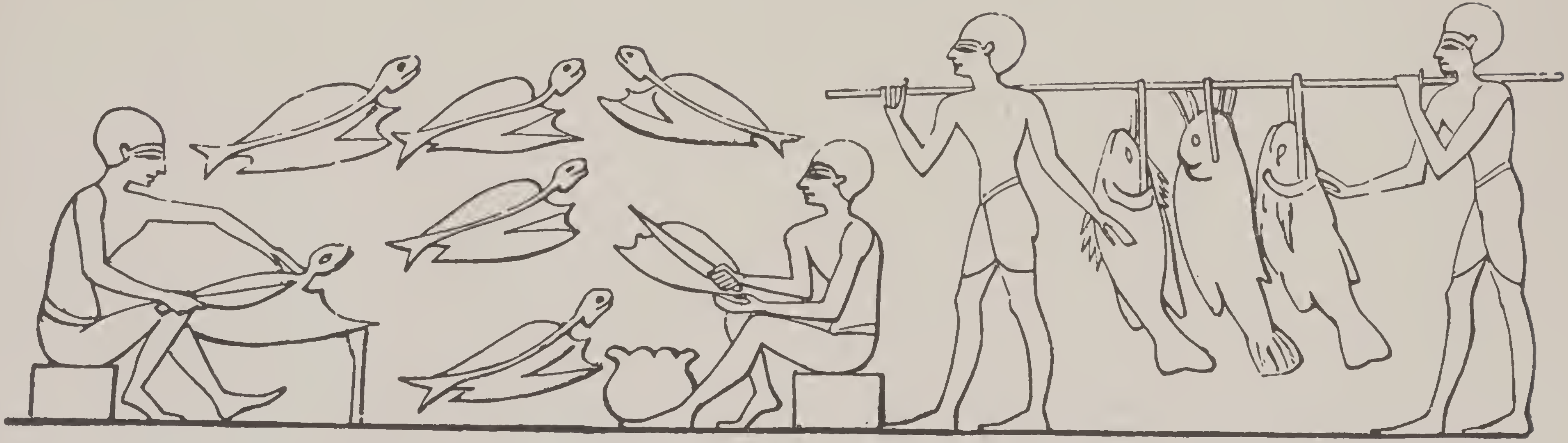
Prehistoric Times

Fish and shellfish were one of primitive man's main foods in his earliest days as a food gatherer. It was in search of fish caught by hand or by bone harpoon that he spread along the seaboard and up rivers. The catch would have varied from day to day and there must have been seasonal fluctuations in supply, as there are to-day. Fish surplus to requirements would have to be stored in times of plenty to provide for a dearth, and as an historian has phrased it: 'A permanent surplus of food is the necessary basis for the emergence of civil society.'

Drying in the sun and wind when the climate was favourable was probably the earliest method used. The control of fire led to cooking and artificial drying by exposure to the heat and smoke of burning wood. Smoke also served to keep off flies whilst the fish was drying. There is evidence that before the end of the Old Stone Age fish was being preserved in an organized fashion. Thus, the bones of sea-fish are commonly found in the refuse heaps of Upper Palaeolithic cave dwellers of the Magdalenian period in the Dordogne of West Central France.[1] This indicates that trading must have begun, but there is no evidence as to how the fish were preserved to be taken so far inland.

In the Neolithic period, improved bone harpoons and bone hooks were used. Boats were probably developed as aids to fishing before they were used for voyaging. About 2000 B.C. on the River Bann in Northern Ireland, fishers used to kindle fires in hearths on the marshy flats beside the river during the dry season. The Bann is still a good salmon river and it has been suggested that fish may have been smoked there year after year, since little or no kitchen refuse is found amongst the ashes in which conditions for the preservation of the former should have been rather favourable.

The first use of salt is associated with the transition from a nomadic to an agricultural economy: it was not physiologically



By courtesy of *John Murray (Publishers) Ltd.*

FIG. 1.—Ancient Egyptians cutting up fish for salting and drying. Note the receptacle for offal.

necessary until the consumption of grain had largely replaced that of fresh flesh and milk.[3] Salt is localized in occurrence in mines and coastal regions. It could only have been widely used for preservation after commercial interchange of commodities had developed.

PRACTICES OF PRIMITIVE PEOPLES

It is natural in this context to glance at the methods employed amongst primitive tribes for preserving fish, although circumstances are not strictly comparable because even the most backward peoples have been influenced by the diffusion of culture from more advanced areas. Moreover, this process has been accentuated since the 'opening-up' of Africa and the general improvement in communications in the twentieth century. Nevertheless, travellers' accounts of African tribes, soon after discovery, provide an insight into the type of processes that might have been used in prehistoric times.[4]

Drying in the sun or over smoky fires is without doubt the commonest procedure. The use of salt is rarer, and salted fish is still not popular over most of Africa in spite of the pronounced physiological need for salt, which it is preferred to add to food separately. Potassium carbonate, occurring in wood ashes, has been used instead of salt, as by the Bongo of Eastern Sudan (who had a reputation for being expert at working iron), the fish being split lengthwise, sun-dried and smoked in the living huts. No fish would be too small to be considered. It is reported that in South Africa fish only the size of minnows were sun-dried whole, although the flavour of the product was very pungent. In some places, small fish taken straight from the stream, whole and ungutted, were pounded in a wooden mortar and the paste dried in large heaps in the sun, turning black in the process. This product was eaten by breaking off a piece, adding boiling water and mixing with a cereal. Larger fish would be cut up and dried and then powdered in a mortar and rolled into balls, again for flavouring predominantly cereal dishes. Mungo Park, in the area between the Senegal and Gambia rivers, about 1795, found fish being sun-dried and then rubbed with shea butter (obtained from the shea tree and similar to palm oil) presumably to prevent uptake of moisture. Such observations may perhaps be drawn upon to supplement the necessarily meagre archaeological record of earliest times.

BRONZE AGE

Bronze Age civilizations were founded on the river systems of the Nile, Tigris, Euphrates, Indus, and Yellow River, whose periodical flooding made early agriculture possible. Fishing must have played a considerable part in this economy. Improved methods were developed for catching fish, by line and net, and for preserving them by salting and drying.

The discovery of the technique of smelting permitted the development of the metal fish-hook. In Mesopotamia, copper and bronze fish-hooks which were found at Ur and at Jemdet Nasr, near Kish, not far from Babylon, date from about 3500 B.C.[5] Some bronze fish-hooks from Egypt, now in the British Museum, are much later, from between 900 and 500 B.C., but a picture of angling is extant dating from about 2000 B.C. About 1400 B.C. lead was being used in Egypt as sinkers for fishing nets, usually in the form of flat strips bent over the strings, and the same occurs also in Cyprus and Palestine about 1200 B.C.

The main food of the early Egyptians was bread, but common salt was used for preserving fish and birds, although not for meat which was dried in the sun. Salt fish (called *ukas*), which was quite an important food, was made by splitting open, salting and drying in the sun (*see* Fig. 1).[6] Some were cut in half and suspended on ropes to accelerate the drying in the wind. Sometimes the body was simply laid open with a knife from head to tail, the two sides being divided as far as the backbone. In many instances, depicted in the tombs, the process consisted solely in taking out the intestines, removing the head and tip of the tail and exposing the fish, when salted, to the sun. Fresh fish was also much eaten in Ancient Egypt and fish intended to be eaten fresh was sent off to market at the end of the day's catch. The Israelites remembered with regret (about 1200 B.C. perhaps) 'the fish they did eat in Egypt freely' (Numbers, XI, 5). Mackerel were not dry-salted like other fish but were pickled in brine, after the manner of such fatty fish to this day. If kept below the surface of the brine, the fat does not oxidize so readily to produce a rancid flavour, as is the case when the fish are exposed directly to atmospheric oxygen (*see* p. 53). Picklers in Ancient Egypt were temple officials specially entrusted with the knowledge of the 'art'. The word for the preservation of fish by drying and salting was the same as that used to denote the process of embalming mummies. Preservation by smoke appears to have been unknown, possibly because artificial drying was unnecessary in such a sunny climate. There were religious observances connected with fish eating, as in Catholic Europe. At a later date, the Ptolemies held salt monopolies.

In the early Mesopotamian civilizations, too, salt was used for preserving fish. At al'Ubaid, a suburb of Ur, about 3500 B.C., fish together with a quern-ground barley porridge were the chief foods. Although the staple foods were vegetable in origin, fish in dried, salted and smoked forms, was largely eaten throughout Sumeria. A trade in dried fish developed with settlements on the Persian Gulf.[7] Similarly, Mohenjo-Daro, the great Bronze Age city on the Indus, was supplied with dried fish from the coast of the Arabian Sea 150 miles away.[8]

In the Mediterranean, the Phoenician colonies in Spain, e.g. Cadiz, traded extensively in salt fish.[9] Sidon meant 'the fishers' town'.

GREECE

The production and trade in dried and salted fish developed considerably during classical, Iron Age times. However, it has been pointed out by Professor Gordon Childe[10] that no universal Aryan roots have survived for fish (excepting *lachs*, *lax*, *laks*, etc., for salmon) or salt. Fishing is never mentioned in the Veda or the Avesta (the sacred text of the ancient Iranians, attributed to Zoroaster). The repugnance felt by the Greeks of Homer (about tenth century B.C.) for a fish diet is notorious. Although fishing by spear, net, rod, and hooks is occasionally mentioned, the references are rather derogatory. Nevertheless, by the sixth century B.C. fishing was the main occupation and habitual source of food of many shore-dwelling populations in the Greek archipelago and the colonies of the eastern Mediterranean from Sicily to the Bosphorus. Fish, fresh, dried, salted, and smoked, became a common and popular dish.[11] Tunny were

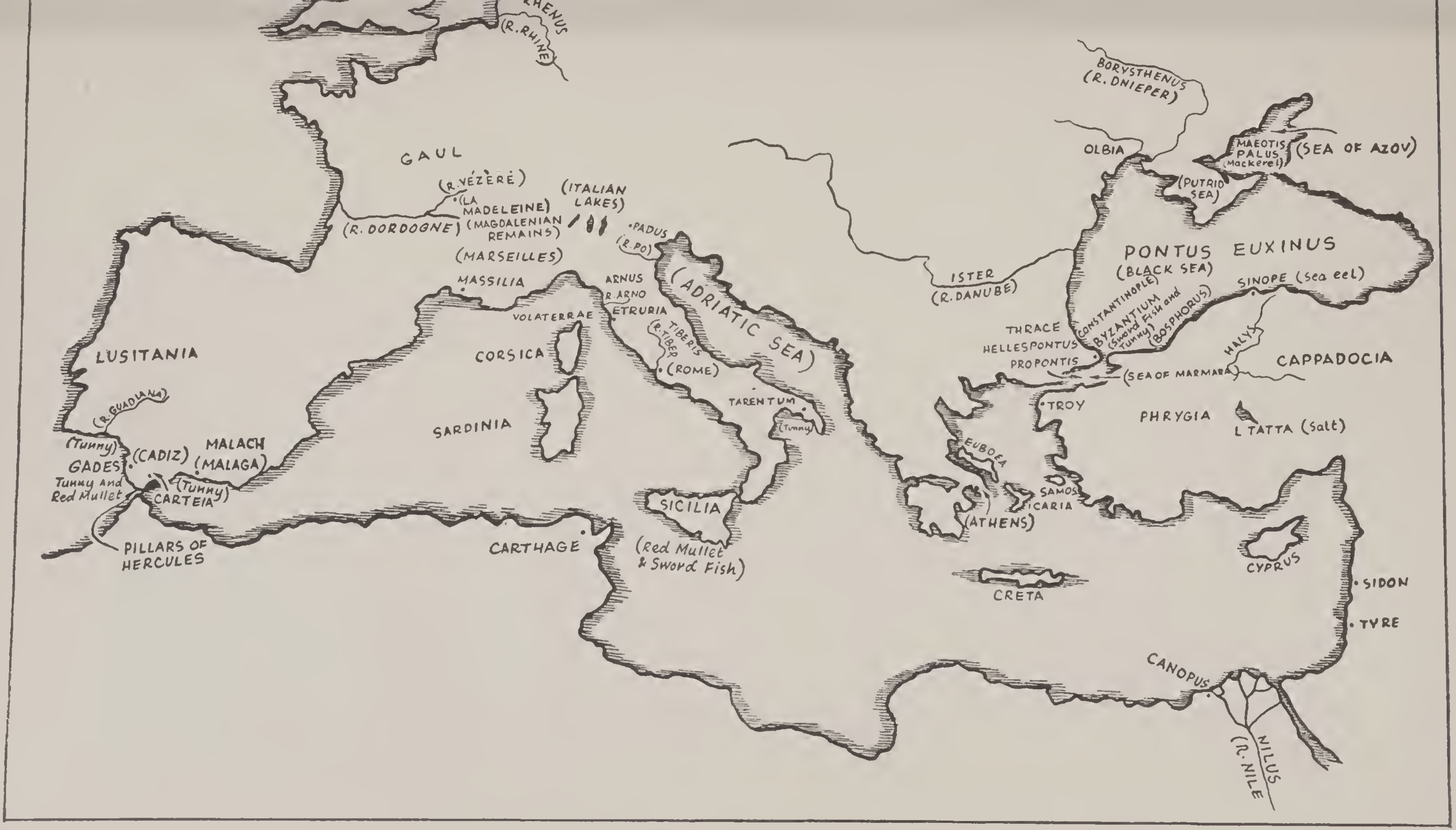


FIG. 2.—Centres of Fishing Industry in Classical Times.

preserved with salt on the islands of Euboea, Samos, and Icaria (meaning, 'the coast rich in fish'). Byzantium (afterwards Constantinople) and Sinope, on the southern shore of the Black Sea, were originally fishing villages which salted fish and traded in the product. Salt, lumps of dried fish, and jars of salted and pickled fish were sent from the mouths of the Dnieper and the Sea of Azov to Athens and other Greek cities.

In later, Hellenic, times, the Black Sea and the Straits continued to supply a great part of the fish consumed by the Greeks. One historical writer comments that 'the Black Sea and the Sea of Azov became what the banks of Newfoundland were to the maritime states of Europe during the first centuries after their discovery.'[12] Lake Maeotis (the Putrid Sea, in the Crimea) and the southern shores of the Black Sea were amongst the most famous and prolific areas. Many cities owed their prosperity mostly—if not entirely—to the export of dried fish, salted and pickled fish (*tarichos*), and smoked fish. Coins were often stamped with the figures of fish: thus Olbia, near the mouth of the Dnieper, which was one of the most important fish markets, had on its money a representation of an eagle capturing a fish.[13] The coins of Cartheia, on the Bay of Gibraltar, depicted an angler taking a fish. Each town seems to have had its own particular recipe for pickled fish, which was often an expensive luxury. Commoner forms, probably the dried lumps rather than delicatessen jars, were eaten by the Athenian soldiers on campaign. Xenophon in his description of the retreat in 400 B.C. of the 10,000 Greeks from Persia along the southern shore of the Black Sea, foraging as they went, mentions that one of the tribes that fled before their approach left behind jars of pickled fish.

In Egypt, where the glory was now long past, the Nile was fished throughout this period by harpoon, line and scoop, lobster-pot and something resembling a seine net. Fish intended for immediate consumption were usually dressed on the boat and dispatched quickly to market. The rest of the catch was opened up ashore, and either headed and gutted or split, then salted and hung on ropes to dry in the sun. The fish were not split straight down the back, but always rather to one side or the other; this practice continues there to the present day. The hot climate of Egypt made prompt curing important. The fish were exported far and wide: Egyptian *tariche* from Canopus, on the western mouth of the Nile went in baskets or barrels to Palestine. A favourite fish was the *Mormyrus*, or 'elephant snout fish' (*oxyrhyncus*) still caught in African fresh waters.

The Carthaginians at their height fished in the western Mediterranean and in the Atlantic south of the Pillars of Hercules (Straits of Gibraltar). One of their settlements was Malaga, or 'Malach' in Punic, which means 'the salting place'. Their fishing vessels often stayed at sea for considerable periods, and tunny was preserved on board.

ROME

The Romans raised salting to a high degree of perfection, and salted fish became a far commoner food than it was amongst the Greeks. After the Punic Wars, cargoes of smoked and salted fish (*salsamentum*) came to republican Rome from the Black Sea, southern Spain, Sicily, Sardinia, and Tripolitania, where many ports existed by the salt fish industry. Individuals amassed large fortunes by dealing in fish and thousands of slaves were educated as sailors and fishermen to man large commercial enterprises.

Two hundred different ways of preparing and preserving fish were listed by one classical writer (Athenaeus, about A.D. 200.). A certain amount of fresh fish was marketed where quick sale was possible. To encourage expeditious handling and thus guarantee freshness, one law prevented fishmongers from sitting down at their stalls. Most of the fish was, however, salted. The main species were red mullet, bream, 'asellus' (hake?), mackerel, tunny, eel, sea eel (conger) and swordfish. Fig. 2 shows on a map the places particularly famous for these fishes. Preserved by salt, they were sent all over the Roman Empire. 'When you come to Byzantium', says one writer, 'take a piece of salt swordfish, and choose a slice of the back nearest to the tail.' Large fish were cut into pieces and underwent various processes, some simple and some complicated, all of which had special names. Spices and odoriferous herbs were used along with the brine, marjoram being popular with conger eel. Cooked fish was often packed with herbs only, and although some herbs have a little bactericidal effect, such products could only have kept for a relatively short while. Mullet roe, when salted, was a favourite dish with all classes, and must have been a similar product to *botargo*, which is still eaten in Mediterranean countries (*see* p. 43). A fermented fish sauce made from fish entrails was greatly esteemed. Known as *garum sociorum* because it was produced by a kind of fishermen's co-operative using a recipe which was a closely guarded secret, the product must have been somewhat similar to the *nuoc mam* of Indo-China to-day. The word *garos* is still used in Greece for an enzyme preparation of fish viscera. A fish sausage, *Irsicia* or *Isicia*, was also held in great favour in Rome. Fabulous prices were sometimes paid for fish products. One small flask of Pontic (i.e. Black Sea) *salsamentum* at times fetched as much as or more than a hundred sheep.

The Mediterranean tunny fishing, which extended from Gades (Cadiz) to Tyre and Sidon, was the best organized and most profitable. *Salsamentum*, made from tunny, travelled far and wide. The Romans learned from the Greeks a method of preserving the fish by frying in oil, treating with bay leaves, salt, and spices and then pouring boiling vinegar over it; mackerel were also treated in this way. The process resembles that used for 'Newcastle salmon' at a later period and for marinated herrings to this day.

Tarentum had a great reputation for its salt fish, especially for its delicate tunny. So also had Sicily, Sardinia, and Lusitania (i.e. southern Portugal). The Sea of Azov and the Black Sea coasts continued to support important fisheries. There was a large salting establishment at the mouth of the Halys and another important tunny fishery off the coast of Thrace.

The favourite portions for salting were the gristly parts near the head, although other parts of the body were also used. Tunny was, in fact, preferred in the salted form to the fresh, since it was then more easily digestible. In a similar way, even to-day, canned 'tuna' is the main outlet for the tunny species, which are usually unduly tough when eaten fresh. Whales, seals, and sharks were also taken in the Atlantic.

During the Empire, river fishing was developed and the Po, Rhine, Danube, and lakes of northern Italy all sent fish to Rome. Artificial ponds, or *vivaria*, were kept stocked for the table and fertilized eggs were collected for them.

Sea fish must also have been landed alive, because one of the pleasures of a Roman banquet was to see the colour changes of the red mullet as it died, before cooking and eating it.

SALT IN CLASSICAL TIMES

Both Egypt and Asia Minor were rich in salt. The salt lakes of Phrygia and Cappadocia, especially Lake Tatta, and deposits in Lesser Armenia, were all utilized in Greek times, but the Romans exploited all available resources even more intensively. A state salt monopoly was also instituted.

Salt pans and mines were worked all over the Roman Empire; at the mouths of the Tiber and Arno, Sicily, Africa, Spain, Gaul, Flanders, the Balkans, Asia Minor, Cyprus, and Egypt. At Volaterrae in Etruria 'the sea enters upon a slope by channels dug in the ground, and a small stream fills innumerable pools. But when the Dog-star comes with his burning fires, when the grass fades and all the land is athirst, then the sea is shut out by the barrier of sluices, so that the water, held fast, is hardened by the hot ground. Under the lively influence of Phoebus, the elements coagulate into a thick crust.'[11] This is exactly the method used in the salt marshes of Italy at the present time. Rock salt was hewn from the mines in blocks by slaves. Of Lake Tatta, a writer of the time said, 'the salt contained in its water sticks so readily to anything which one dips in it, that if you put in a heap of reeds you draw out a crown of salt.'

On the fringe of the Roman Empire, much cruder and less organized methods were in use. On the coasts of Essex and Lincolnshire, salt was already being produced in the early Iron Age, several centuries before the Roman conquest. In our climate, solar radiation was insufficient to concentrate the brine so that artificial heat was necessary. There are signs that the method used was to evaporate sea-water, either in dishes, or by pouring it over a heated framework of baked clay bars and scraping off the salt.[14] In Gaul and Germany, Pliny reported that salt was made by pouring sea-water over burning logs. Oak was considered best because it had a clear ash, but hazel was also used. The salt made in this way was quite black, but was nevertheless probably used chiefly for curing fish, meat, and hides. The Romans introduced the use of leaden evaporating pans, which made bulk evaporation possible, and resulted in economy in the use of fuel.

PRICES

It is impossible to estimate the relative amounts of fish dried with and without salt in classical times. However, fresh fish was scarce. This is shown by the edict, issued by the Emperor Diocletian in A.D. 301, which attempted to fix the maximum prices of foodstuffs. Fresh fish appears to have been several times more expensive than salted fish.[15] Since the latter shrinks during processing it is normally to-day a dearer commodity than fresh fish on a weight basis. However, even salt fish, at the equivalent of 4½d. per lb. was far beyond the reach of the average urban workman, who received in cash only 5¼d. per day if unskilled and double this if a tradesman, e.g. a carpenter. As one historian writes: 'The taste of meat, fish, butter and eggs must have been almost unknown to him, and even the coarse bread and vegetables on which he lived were probably limited in amount.'[11] Nevertheless, Licinius (A.D. 311–23) decreed that on certain days of the year, only salt fish could be eaten, thus anticipating the 'fish-days' and Lent prohibitions of the Roman Catholic Church. The attempt to reduce the cost of living was abandoned by A.D. 313 after many executions for infringement of the maximum prices order. Sixty years later, towards the end of the Roman Empire, the Emperor Julian made a similar attempt to control prices, but was defeated by corn speculators.

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Chapter 2

FISH IN PRE-INDUSTRIAL TIMES

Fish was an important element in the food supply everywhere in the early Middle Ages. Records from the sixth century onwards show the English, French and Flemings actively engaged in the Channel and North Sea fisheries, and disposing of their products.[1] An ordinance of Æthelred (A.D. 979–1016) concerning tolls at London, then a town of perhaps 25,000, reveals that there were merchants from the Netherlands, northern France, and northern Germany importing fish, obviously preserved.[2] Even earlier, in the ninth century, the Dutch were buying salted fish from the Scottish east coast fishermen.[3]

Towards the end of the Middle Ages, several main types of fishing were discernible, viz. fresh water, salmon, inshore, herring, and the distant water white fishery. Of these, the latter two, which are dealt with in later chapters, would have been impossible without adequate methods of preservation: the white fishery because of the distance, and the herring fishery because of its seasonal nature and the quantities involved. Salmon were also mostly eaten in preserved form. The inshore fishery from small, undecked, rudderless vessels must have been a hazardous and uncertain source of supply. In any case, transport was so slow that very little of the home production of sea fish could be eaten in the fresh state, so that most of it, too, had to be preserved.

FRESHWATER FISH

Rivers, brooks, ditches, and ponds were the only reliable source of fresh fish. Freshwater fish was an important by-product of the numerous water mills, which were one of feudalism's main contributions to industrial technique. Few villages mentioned in Domesday Book (1086) were without at least one. The rent was often assessed in terms of money and fish. Thus, three at Harmondsworth paid 60*s*. and 500 eels per annum, and, together with fish ponds valued at 1,000 eels, were the perquisite of the Norman Abbot of Holy Trinity at Rouen.[4] In the Fens, fishing, together with fowling, was the basis of the fenmen's livelihood. William of Malmesbury writes: 'Here is such a quantity of fish as to cause astonishment in strangers, while the natives laugh at their surprise.' For example, Doddington, in the Isle of Ely, yielded 27,150 eels and 24*s.* to the Abbot of Ely. Even in 1600 rents in the Fens were still being paid in terms of so many thousands of eels.[5] Drainage by Vermuiden in the middle of the seventeenth century, which was resisted bitterly by the fenmen, ultimately put an end to this way of life.

In the days before the land was drained, too, the rivers were not confined between embankments and were therefore broader and flowed more slowly, thus providing a more suitable habitat for coarse fish than is the case to-day.

The monasteries were renowned for their systematic exploitation of the freshwater fishery, but nobles and gentry also took a share. Thus, Chaucer's Franklin kept

'many a breem and many a luce in stuwe.'

Pike is *Esox lucius*. 'Stews', or dammed-up fish ponds, were often artificially stocked for the table with carp, tench, eels, etc. In the fifteenth century, the King's pike ponds at Southwark supplied the royal table.

In Elizabethan literature, freshwater fish occurs more often than sea fish, which when mentioned is usually either salted or dried in form, and often regarded as rather poor fare. Ben Jonson writes of

'Fat, aged Carps, that runne into the net,
And Pikes,'

that apparently give themselves up, too. Shakespeare's characters use dace, pike, tench, eels, salmon and trout in simile and metaphor. Shellfish, taken on the shores, are quite conspicuous, with oysters, cockles, 'whelks and knobs', referring to Bardolph's face, and crabs. Of sea fish proper, conger (eaten with fennel) is not criticized, but mackerel is 'stinking', and 'Poor John', stockfish and 'old ling', all various forms of salted and dried cod, are obviously not very highly thought of. Moreover, it was 'pickle-herring' that plagued Sir Toby Belch; it is also supposed to have been responsible for the early death in 1592 of Robert Greene, one of the more boisterous Elizabethans and author of *The Honorable Historie of frier Bacon and frier Bongay.* 'White herring', which were the same thing, are mentioned in *King Lear. Henry IV* is particularly rich in references to fish. Thus Falstaff (*see* p. 35) also refers to 'shotten herring', i.e. herring which had spawned and were in poor condition, and later on exclaims: 'If I be not ashamed of my soldiers I am a soused gurnet.' 'Sousing', by pickling in hot vinegar, is to-day mostly used for herrings, but no doubt any smallish fish, such as gurnard, would be similarly preserved.

Camden, writing about the same time, of Worcestershire, in the part of the country where Shakespeare spent his youth, says that it 'hath in all parts very fine rivers which furnish it plentifully with fish of the most delicious kinds', including lampreys and eels which 'are best in season in the Spring, as being then of a most delicious taste, whereas in the Summer the string within them, which doth the office of a backbone, groweth hard.'

John Evelyn, the diarist, writing between 1640 and 1665, noted that many manors had their own artificial fish ponds, the dried-up beds of which can still be seen.[5] By this time, and that of Defoe (1661–1731), however, their function was partly ornamental. Fishing, along with fowling, were the poor men's sports, free from the penal restrictions of the Game Laws. Nevertheless, for Izaak Walton (*Compleat Angler*, 1653) angling was still as much a source of food as a recreation, as his detailed instructions for cleaning and cooking the catch clearly show. Even minnows were eaten as 'Minnow-tansies'; after washing in salt, heading, tailing, and gutting, they were 'fried with yolk of eggs, the flowers of cowslips and of primroses, and a little tansy; thus used they make a dainty dish of meat.'[6] The Thames itself at London was a good river for many sorts of fish until polluted by sewage and gas-works effluent in the early nineteenth century. As late as 1766, 130 Thames salmon were sent to Billingsgate.[7] Its last recorded catch of salmon was in 1833.

LIVE FISH

Keeping fish alive can be considered as a form of preservation in the case of a commodity so perishable once it is dead.

Not only were freshwater fish kept alive relatively easily in fresh water, but they were even transported alive long distances by road. Thus, Daniel Defoe in 1724 describes the land carriage of live fish from the River Nen in the Fens:

> 'Here is a particular trade carry'd on with London, which is no where else practis'd in the whole Kingdom, that I have met with, or heard of, (viz.) For carrying fish alive by land-carriage; this they do by carrying great buts fill'd with water in waggons, as the carriers draw other goods: The buts have a little square flap, instead of a bung, about ten, twelve, or fourteen inches square, which being open'd, gives air to the fish, and every night when they come to the inn, they draw off the water, and let more fresh and sweet water run into them again. In these carriages they chiefly carry tench and pike, pearch and eels, but especially tench and pike, of which here are some of the largest in England. Whittlesea and Ramsey meres are indeed full of excellent fish for this trade.'[8]

There must have been considerable losses on the way, and those that survived the long, lumbering journey by wagon along early eighteenth-century roads must have arrived more dead than alive. The condition of much of the live freshwater fish on sale in the Middle Ages may be judged by the remarks directed by Berthold of Ratisbon 'to him who selleth fish. Thou keepest thy fish captive in water until Friday come, then they are corrupt, and a man eateth his death by them, or some great sickness.'

As late as 1870 Bertram noticed live salmon on the Maas a few miles above Rotterdam.[9] They were netted by means of a small steamboat and 'at once carried in a hand net to a large floating iron tank, pierced with the necessary holes for permitting a full supply of water.' The fish were killed and sold every morning at a market, as required.

There are still a few isolated survivals of this technique of preservation in the live state. Thus, live, line-caught cod can still be seen in Norway at Bergen fish market, brought back in the wells of small fishing craft, and until not long before the last war were sent alive in tanks by rail to Oslo. Live fish, particularly plaice and soles can also be seen at Esjberg in Denmark. Herubel[10] reports that fish were towed through the North Sea behind the fishing vessel in curved boxes, and after removal from tanks at the port were sent considerable distances by rail, e.g. to Berlin. The tanks were made like boilers, and the water was oxygenated and filtered. In Paris, a restaurant had (in 1912) recently installed sea-water tanks, from which diners could select fish for their meal. The English live fishing, described in Chapter 9, had practically died out by this date.

OYSTERS

Oysters in the sixteenth century were being kept alive in brackish water for as long as twelve days. Perhaps the comparative ease of preservation in fresh condition in this way explains why they were so relatively cheap until recent times. In London in 1491 they were only 4*d.* per bushel. Oysters are mentioned by Shakespeare in at least six places, which is more often than any other species of fish. They were also preserved by pickling in some way, probably with salt. Thus Parson Woodforde gets a small jar of them as a present from his father in 1764.[11]

Oysters were brought not only to London, but beyond, to the seats of noblemen in the country. Dr. Thomas Fuller (1608–61), the Royalist Chaplain, records having heard that 'oisters put up with care, and carried in the cool were weekly brought fresh and good to Althrop, the seat of Lord Spencer, which was 80 miles from the sea, and it is no wonder for I myself have eaten in Warwickshire, above 80 miles from London, oisters, and sent from that city fresh and good, and they must have been carried some miles before they came there.'[12]

In 1783, oysters must still have been quite cheap in London because Boswell says of Hodge the cat belonging to Samuel Johnson, who was by no means affluent, that 'he himself used to go out and buy oysters' for it,[13] implying that these in fact were the cheapest variety of fish obtainable. About the same time, Smollett makes his curmudgeonly old character, Matthew Bramble (in *Humphry Clinker*, 1771), see the blacker, and on the whole more credible, side of this picture. He remarks that 'the right Colchester are kept in slime-pits, occasionally overflowed by the sea; and that the green colour, so much admired by the voluptuaries of this metropolis is occasioned by the vitriolic [in the sense of green vitriol or iron sulphate?] scum which rises on the surface of the stagnant and stinking water.' At the time of

Pickwick Papers (1836–37), they must still have been cheap and plentiful. 'Poverty and oysters always seem to go together . . . the poorer a place is, the greater call there seems to be for oysters . . . here's a oyster stall to every half-dozen houses [in Whitechapel]. The street's lined vith 'em. Blessed if I don't think ven a man's wery poor, he rushes out of his lodgings and eats oysters in reg'lar desperation.' In 1840 they were still only 4*d.* per dozen, but about 1850 suddenly became scarce and dear owing to reckless exploitation to supply the rapidly expanding towns. The south bank of the Firth of Forth, once as famous for its oysters as the coasts of Kent and Essex, was similarly denuded. In 1723 Defoe noted that 'They take great quantities of oysters upon this shore also, with which they not only supply the City of Edinburgh, but they carry the abundance of them in large, open boats, called cobles, as far as Newcastle-upon-Tyne.'[14] Mussels were quite an important industry at Harwich, although on the Forth, at 'Musclebro' ' and 'Fisherraw', where formerly 'the Muscle Fishery was counted a valuable thing, 'tis now given over; tho' the muscles lye on the shore, and on the shoals of sand in the middle of this river in vast quantities.'

LENT

Before the development of turnip husbandry in the eighteenth century, fresh meat, which was in any case often beyond the normal means of most people, was available only in the summer months. Since the grass did not grow and there was therefore no feed for the animals during the winter, the best ones were mostly killed off and the flesh salted and the fat boiled down in the autumn. Those beasts whose loss would not have mattered much anyhow, they tried to keep alive through the winter for breeding purposes. If they survived, they sometimes had literally to be carried into the fields in the spring. Butter and beef dripping did not last indefinitely and the last rancid remainders would be consumed in the pancakes of Shrove Tuesday. The rich could afford freshwater fish, but the only protein food left to tide ordinary people over until after Easter when fresh meat, cheese, and eggs became plentiful again, was salt fish. The economic and technological realities of peasant production in

Europe corresponded with the religious observance of Lent in Catholic countries, i.e., in all countries before the Reformation in the early sixteenth century.

Laying in a stock of salt fish for Lent was an important business, as can be seen from the correspondence with their estate managers of the independent landed proprietors emerging with the decay of feudalism. The struggles of one such family during the turmoil of the Wars of the Roses are preserved for us in the Paston Letters (1422–1509).[15] Paston is on the Norfolk coast between Yarmouth and Cromer, and thus conveniently situated to take full advantage of the East Anglian herring fishing in the autumn. Thus on 19th November, 1477, William Pekoc warns his master, Sir John Paston, 'herying wol be dere or Lente' but that although he had some at a 'prysse of . . . iiij*£*. iij*s*. iiij*d*.', he could get 'no caryage, nowthir owte of Yermowth, ner in no oder place be tyne Wynterton and Leystoft, nowthir be lond nor be the se, not yet.' About the same time Richard Calle writes to Margaret Paston: 'Mastres, it were goode to remembre your stuffe of heryng nough this fisshyng tyme. I have gotten me a frende in Lestoft to help to purvey me of an vij. or viij. barrell, and shal not stonde me upon above vji*s*. viij*d*. a barrell . . . ye shall do more nough with xl*s*. then ye shal do at Cristemes with v. marke (66*s*. 8*d*.). The fisshyng at Yermough wol not be so goode as it wol be at Leystoft, for the haven wol not prove yette (open).' Another year, for some unexplained reason, Margaret had not been able to purchase her lenten stores until late in the season, but was able eventually to write to her husband: 'As for herring, I have bought a horse load for 4*s*. 6*d*. I can get no eels yet.' The Northumberland Household Book lays down 'the ordre of all such Braikfastis as shal be allowid daily in my Lordis house Every Lent.' That 'for the Nurcy for my Lady Margaret and Maister Ingeram Percy' includes, along with bread, butter and 'a Quarte of Bere,' 'a Pece of Salt fisch a Dysch of Sproitts or iij White Herrying.' 'My Ladis gentyllwomen' did not apparently get the option of the sprats.[16]

The household account books of Sir William Petre, of Ingatestone Hall, in Essex, who was a fellow Secretary of State of Cecil in the days before Prime Minister and Cabinet, show that in 1549 he had laid in store for Lent: 'haberdine 75½ couple, ling 46½ couple, stockfish 56 couple, red herring two cades (*see* p.

71) white herring a barrel, salted eels a barrel, salmon half a barrel, and six salted congers, besides a barrel of frying oil.'[17]

Salt cod kept better than pickled herring, if the rhyming doggerel of Thomas Tusser (1524–80) can be relied upon:

'Spend herring first, save salt fish last:
for salt fish is good when Lent is past.'[18]

Long after the Reformation in England, the exigencies of the Lenten fast to a large extent determined the annual rhythm of production and even the dates of sailing of ships carrying preserved fish to Catholic countries on the Continent.

Elizabethan Nashe's panegyric to the red herring, suspected of being in the nature of a *quid pro quo* for hospitality received at Yarmouth, is significantly entitled 'Lenten Stuffe . . .' (*see* p. 72).

Eminently sensible Martin (Luther) in Swift's *Tale of a Tub*, unlike his dogmatic brother Jack (Calvin, Huss, Knox), removed only so many of the popish trappings as did not, by their excision, tear the suit adorned by their elder brother Peter (Rome). Lent was too useful an institution for the reformed Church of England with the Sovereign at its head to dispense with.

Attempts to enforce observance of 'Fysshe days' and Lent during the latter half of the sixteenth century must be attributed to the dearth of meat and the needs of the navy that was to oppose Philip of Spain rather than to religious fervour.[16] In fact, it was stated that the objects were to stimulate fishing and shipbuilding, maintain the seafaring population and revive decayed coastal towns. In 1548 Saturday, in addition to Friday, was made a meatless day by Act of Parliament, 'considering that due and godly abstinence is a means to virtue and to subdue men's bodies to their soul and spirit, and considering, also specially that fishers . . . may thereby be rather set to work, and that by eating of fish much flesh shall be saved.' In 1563, Cecil advocated ' . . . the strictest observation of fish days, for policy's sake so the sea-coasts should be strong with men and habitations and the fleet flourish more than ever.' He tried to get Wednesday accepted as a third fish day; together with Ember Days and Lent, this would have made more than half the year meatless. In 1563, a London woman was pilloried for having meat in her tavern during Lent.[5] In 1571, the Privy Council was busy with the returns of J.P.s as to the enforcement of these laws in the various counties, including inland counties such as Northamptonshire and Buckinghamshire. One effect of the laws was probably to prolong the use of 'stews'. Attempts to enforce additional fish days were abandoned in 1585, although it was pointed out in a proclamation even in 1595 that 135,000 head of beef 'might be spared in a yeare, in the Citie of London, by one dayes abstinence in a weeke.' This campaign was expressly dissociated from any religious significance. At the same time an attempt was made to stimulate home shipping by forbidding subjects to import foreign cured fish. Thus in a proclamation of 1598 'it was hoped and expected that the people of this realm . . . should by ere this time have been able to have victualled this realm with salted fish and herrings of their own taking' but they were 'not able to furnish the tenth part of the same with salt fish' so that 'the chief provisioning and victualling thereof with fish and herrings hath . . . been in the power and disposition of aliens and strangers . . . who yet do serve the market here in very evil sort, by little and little, bringing and keeping their fish as well on this side as beyond the seas till the prices be raised to their liking.'[18] But times were bad at the end of the century and the lower classes were forced in any case to eat more salt fish instead of flesh and 'white meats', i.e. milk and cheese.[16] Immunity from Lent could be purchased or obtained by means of a medical certificate (*see* p. 4).

In 1621, when James I issued a proclamation against eating flesh in Lent and on fish days, it was again acknowledged that:

> 'The reasons now assigned for this injunction are for the maintenance of our navy and shipping, a principal strength of this island, and for the sparing and increase of fresh victuals. The magistrates of London to examine upon oath the servants of all inn holders, victuallers, cooks, all housekeepers, taverners, etc. who sell victuals, concerning what flesh has been sold by them in Lent, etc., and shall oblige the masters of those houses to give security not to sell flesh-meat in Lent, etc.'

It seems unlikely that much notice was taken of this either, because two years later he issued a similar proclamation. The

Puritans, of course, castigated all this legislation as 'rags of Rome.' However, even during the Commonwealth, Piscator in the *Compleat Angler* in praising otter-hunting, says that 'the want of otter-killers and the not keeping the fence-months [close seasons] for the preservation of fish, will, in time, prove the destruction of all rivers. And those very few that are left, that make conscience of the laws of the nation, and of keeping days of abstinence, will be forced to eat flesh, or suffer more inconveniences than are yet forseen.'[6]

After the Restoration there was another similar attempt to establish three fish days a week and to enforce Lent, which had been in abeyance since 1640. At the same time, significantly, renewed efforts were made to revive fishing in 1663 through the Corporation of the Royal Fishery (financed by a lottery and collections in the churches) of which Pepys, in his position at the Admiralty was an assistant Governor. He writes on 14th February, 1660–1, 'The talk of the town . . . (is) whether Lent shall be kept with the strictnesse of the King's proclamation, which is thought cannot be, because of the poor, who cannot buy fish.' On 27th February: 'I called for a dish of fish, which we had for dinner, this being the first day of Lent; and I do intend to try whether I can keep it or no.' On 28th February, however 'Notwithstanding my resolution, yet for want of other victuals, I did eat flesh this Lent, but am resolved to eat as little as I can.' The Corporation, like Pepys's resolution, came to naught.

A proportion of the population, augmented no doubt in the nineteenth century by the Oxford Movement and Catholic Emancipation, must always have treated the religious observance of Lent seriously. Thus, even in 1911, a manual of fish curing, printed in Aberdeen, has a chapter of instructions on 'How to pickle cod for Lent.'[19]

ARMY AND NAVY

Herrings in various forms as well as salt fish were carried as provisions on sea voyages and were as necessary for victualling the army abroad.

In 1281 Edward I sent agents throughout the country to collect provisions for his army preparatory to an invasion of Wales. One Adam of 'Fuleham', who was an alderman of London, Sheriff in 1298 and a London M.P., was commissioned to buy 100 barrels of sturgeon and 5,000 salt fish in Aberdeen. Again in 1284, he was appointed to provide 100 barrels of 500 lb. each of Aberdeen salmon and carry them to Chester.

In 1293 the fishmongers played a notable part in a city pageant to celebrate victory against the Scots, with four sturgeons gilt, four salmons of silver and six and forty knights riding on horses made like 'luces of the sea' (*Merluccius*=hake?).

Herrings, stockfish and ling were amongst the supplies delivered to the English garrisons in Scotland between 1297 and 1300. In 1300 the Castle at Stirling was provided with 18,500 herrings. Edward III in 1338 obtained from Yarmouth 40 lasts of herrings (about half a million) for the army in Flanders. There was even a 'Battle of Herrings' in 1429 during the Hundred Years' War. This was a skirmish at Rouvray round 500 cartloads of herrings sent by the Duke of Bedford (Commander-in-Chief and brother of the late King, Henry V) to relieve the army of the Duke of Suffolk (impeached and murdered, 1450) which was besieging Orleans until routed by Joan of Arc. The barrels themselves were used as an effective barricade in the days before the systematic use of gunpowder, and the attack was beaten off. Sir John Fastolf, who convoyed this supply train, was in part, it seems, drawn upon by Shakespeare for Falstaff, whose fondness for fishy metaphors has already been commented on. Fastolf's seat was at Caister, near Yarmouth, where he died in 1459, immensely rich. The Pastons (*see* p. 31) were neighbours and ultimately inheritors of his properties.

Ships were early taking on salt fish, etc. Thus in 1290 the ship fitted out by Sir Patrick Spens at Yarmouth for bringing home the ill-fated Maid of Norway to Scotland, and immortalized in a famous ballad, was victualled prosaically enough with 200 stockfish, one small barrel of sturgeons, five dozen lampreys, 50 lb. of whale, half a last of herrings and 400 'fish of Aberdeen' (probably salt cod).[3]

Dried and salt cod seems to have been—along with salt beef and pork—the stand-by of the Elizabethan mariner. Hawkins, in 1564, shipped 6 lasts (about 12 tons) of stockfish and 12 cwt. of ling, along with 40 hogsheads of beef and 80 flitches of bacon.[1] Frobisher, in 1577, took 2½ tons of stockfish.

A contemporary writer comments that 'The further south and southwest that the fish well used (well cured) is caryed, the dearer it is and greatly desired.'[20] Dried, salted cod became known as the 'beef of the sea.' Its importance was that it gave shipping the range of the tropics, and thus played its part in the activities of Spain and Portugal in the New World. About 1650, it was said 'Neither can the Hollands, Spaniards or Portugals well get any ship to the Indies without Newfoundland fish, there being no fish that will endure to pass the line sound and untainted but the fish of that country salted and dried there.'

According to John Masefield,[21] the normal animal protein rations for the Elizabethan sea-dogs were:

> 'Salt fish, ling or cod: ¼ side on Wednesday and Saturdays;
> ⅛ of a side on Fridays.
> Salt beef or salt pork with pease: One pound on Sundays,
> Mondays, Tuesdays and Thursdays.'

Along with a diet of ship's biscuits, cheese and butter, 'Beer:—one gallon' was issued, and was of indifferent quality, according to Masefield. Unlike Falstaff's two gallons of sack to a ha'-p'orth of bread, this scarcely seems 'an intolerable deal' for such a thirst-provoking diet. Hawkins on the 1564 trip took 40 tuns of beer, 35 tuns of cider, and 40 butts of malmsey. A graphic contemporary account of what life at sea was really like under these conditions is given by Thomas Nashe, who was a bosom companion of Robert Greene. In a typical rodomontade against the ills of his times, and in particular the difficulties that beset authors, *Pierce Penilesse His Supplication to the Divell*, 1592, Nashe depicts a spendthrift law student who goes to sea hoping to replenish his fortune. 'Poore soule hee lyes in brine in Balist, and is lamentable sicke of the scurvies, his dainty fare is turned to a hungry feast of Dogs and Cats, or Haberdine [large salt cod] and poore Iohn [the smaller salt cod from Newfoundland] at the most, and which is lamentablest of all, that without Mustard . . . It is a pleasante thing ouer a full pot, to read the fable of thirsty Tantalus: but a harder matter to digest salt meates at Sea, with stinking water.'[22]

TRANSPORT BY LAND AND WATER

The Inca rulers of Peru had fresh fish brought to them from the sea by relays of runners covering between 100 and 150 miles in a day.[23] Obviously such means are at the disposal only of a very exclusive minority. The distribution of fresh fish by 'hawking' in neighbouring villages and countryside by the fishermen themselves and their families, is described in the ninth century amongst the Anglo-Saxons.

Navigable rivers were used early on as waterways into the interior. Thus in 1333, three tuns of herrings, most likely salted, were carried up the Thames from London to Henley, a distance of 60 miles, at a cost of 11½*d.* per tun. Later, at King's Lynn, which had access to several navigable rivers, goods including salt fish and stockfish were carried into eight counties and numerous towns, including Ely, Peterborough, Bedford, Stamford, Huntingdon, and Cambridge. A resolution of the States of Holland in December 1585, shows that fresh, possibly live, fish from Scheveningen was at that time sold in the London market.[24]

Roads were also used extensively, long distances being covered on horseback with panniers, and in carts. Fish was carried to London from Rye in medieval times by 'ripiers' with pack horses, each 'dorser', or pannier, being rated to hold a bushel, and fish were supposed to be as good at the bottom as at the top.[25] In 1591, fish from twenty-five fishing boats at St. Ives, in Cornwall, ' . . . victualled the country around for a distance of 60 miles.' In the seventeenth and eighteenth centuries, strings of pack horses, public carriers, carts and wagons carried fish into the interior.

However, the poor condition of the roads by modern, or even by Roman, standards prevented the distribution of fresh fish from the ports on any large scale. Side roads could not be used in winter or in early spring.[7] Daniel Defoe particularly noted in 1724 what a hindrance the bad state of the roads was to the transport and consumption of fish.[8] He enlarged upon 'the convenience that would follow such a restoring the ways, for the carrying of fish from the sea coasts to the inner parts of the Kingdom, where by reason of the badness of the ways, they cannot now carry them sweet; this would greatly encrease the consumption of fish in its season, which now for that very reason, is but small, and would employ an innumerable number of horses and men, as well as encrease the shipping by that consumption.

'By this carriage of fish, I do not only mean the carrying herrings and mackerell to London, as is practis'd on the coast of Sussex and Kent in particular, and bringing salmon from the remote rivers of Severn and Trent; but the carrying of herrings, mackerell, and sprats in their season, and whitings and flat fish at other times, from the coasts of Yarmouth, Swole [Southwold], Ipswich, Colchester, Malden, etc. and supplying all the inland counties with them, sweet and good, which 'tis plain they might do, were the roads made good, even as far as Northampton, and Coventry, and farther too.

'I might give examples where the herrings, which are not the best fish to keep neither, are, even as it is, carry'd to those towns and up to Warwick, Birmingham, Tamworth and Stafford, and tho' they frequently stink before they come thither, yet the people are so eager of them, that they buye them and give dear for them too; whereas were the roads good, they would come in less time, by at least two days in six, and ten-fold the quantity, nay, some say, an hundred times the quantity, be consum'd.'

It took the railway system of more than a century later to realize Defoe's dream.

Nevertheless, the pressure of industrial developments of the eighteenth century necessitated some improvements in the system of communications. The canal network, inaugurated by the success of the Duke of Bridgewater's waterway from Manchester to Worsley in 1755, although quicker than the roads and convenient for durable goods, was still too slow for the transport of perishable commodities. Roads, too, began to be improved. Until about 1750 it took from ten to twelve days to get from Edinburgh to London by passenger stage coach. By 1775 the journey could be done in four days.[26] The pack horses used for normal transport of goods were, however, still considerably slower. Sea transport, also, was too slow to permit the distribution of fresh fish over long distances before the advent of the steam ship in 1812, although the monks of Tynemouth and the Farne and Holy Islands used to send salted and smoked haddock caught locally, and cod and ling caught and salted off the Shetlands to London by sea. 'Newcastle salmon' took several weeks to reach London by boat until, in about 1790, 'one Marshall' took salmon 'fresh from the water to London' on six horses, presumably using ice (*see* p. 214), although Defoe observed earlier that London also received salmon 'fresh' from Cumberland (*see* p. 88).

PRICES

In London, salted and smoked fish were cheaper than fresh fish because of the difficulties of transport and the risks that had to be taken with the latter. Thus in 1298 red herrings were to be had for twenty a penny (or 40*s*. per last) whilst fresh herrings were six a penny before Michaelmas and half that price after.[25] Similarly whitings were four a penny fresh and twelve a penny pickled. 'Large stockfisshe' sold at 1*d*. each, 'Mulvel stokfisshe' at $\frac{3}{4}$*d*., and 'croplenge' at three for a penny. At the coast, e.g. Yarmouth, naturally, the fresh fish was the cheaper.

The prices paid for fresh fish show that they were mostly far beyond the reach of the majority of the population. Conger eels were 12*d*.; turbot, 6*d*.; John Dory, 5*d*.; haddock, 2*d*.; mullet, 2*d*.; gurnard, 1*d*.; mackerel, 1*d*. in Lent and two a penny afterwards; plaice, 1*d*.; soles, four a penny; salmon, 6*s*. between Christmas and Easter, and 3*s*. after Easter; whilst by 1376 it had gone up to 10*s*. A pike of 3 ft. in length cost half a mark (6*s*. 8*d*.) and one of 2 ft., 2*s*., and was thus as dear as salmon. Pickled pike brought from abroad was cheaper, 6*d*. to 8*d*. Roach, not much eaten later even by anglers such as Izaak Walton, were $\frac{1}{2}$*d*. or 1*d*., according to size. Eels were sold by the 'stick' of twenty-five for 2*d*. By 1412 they were sold by weight, small ones at 1*d*. per lb. and large ones at 2*d*. per lb. Small Thames lamperns were twelve a penny, but large lampreys, particularly those from the Severn, beside which Henry III regarded all other fish as insipid, were 4*s*. each before mid-Lent and 2*s*. each afterwards. Imported ones from Nantes were 16*d*. per lb. when they first came in, 8*d*. after a month and 6*d*. after Easter. Shell fish, usually eaten fresh, was relatively cheaper, e.g. oysters at 2*d*. per gallon, or even 4*d*. per bushel, as mentioned above (*see* p. 29).

Fish prices doubled after the Black Death of 1348–52,[27] and as one historian comments 'the humble herring became a luxury.'[28] Prices generally seem to have been much higher again in the sixteenth century when gurnards cost 1*s*. 5*d*. to 2*s*. each, turbot 4*s*. to 6*s*. 8*d*. and salmon 10*s*. to 15*s*. each.

By the eighteenth century, although attempts were being made to transport a little fresh fish to London, the cost of transport and the risk of spoilage still made it a luxury commodity by the time it reached there. Accordingly at Bridport, Defoe writes in 1724 of 'mackerell, the finest and largest I ever saw, were sold at the sea side a hundred for a penny.' At Totnes in Devon, he bought salmon peal 17 to 20 inches long straight from the River Dart for 'two pence a peice [*sic*], and for such fish not at all bigger, and not so fresh, I have seen 6*s*. 6*d*. each given at a London fish-market, whither they are some time brought from Chichester by land carriage.' At Dartmouth, pilchards were seventeen for a half-penny, and he 'might have had as many more for the same money', while 'for 6*d*. or 8*d*. they bought as good lobsters there, as would have cost in London 3*s*. to 3*s*. 6*d*. each.'[8]

FISHMONGERS

It is difficult to draw any hard and fast distinction between the fishing vessel owner and merchant. A Guild of Fishmongers in London can be traced back to 1154, when they were fined by Henry II for carrying on as a trading community without a licence. A charter of 1364 conferred retail monopolies on the fishmonger's company, but they never appear to have been consolidated. Outsiders, such as salters and chandlers, had to be brought in to cope with the increased demand for fish during Lent.[29] Fresh fish was generally recognized as so perishable that hawking by small men direct to craftsmen working in the lanes was encouraged by the authorities. Thus, when the London fishmongers, jealous of their monopoly, tried to put down hawking in 1320, the King's writ was invoked in its favour. There were the usual restrictive medieval practices and frequent regulations attempting to prevent 'forestalling' and 'regrating' (i.e. 'cornering')* and even to control profits of fishmongers, at a penny in the shilling in the time of Edward I (1272–1307). No fish, unless salted, was to be kept in London beyond the second day and no fishmonger was permitted to water fish more than twice. At Southampton, on the other hand, no one was allowed to sell fresh fish except the fishermen who caught it, a further stipulation being added in 1491 that it must be brought to market 'and to no mannys hous oppon paine of forfaiture of the same fisshe and to be prisoned.'

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* 'All the activities which later became the source of power and respect under capitalism were considered in these early days to be infamous and despicable.' (*John Bunyan* by Jack Lindsay (1937), p.34). This seems a fair deduction from Professor R. H. Tawney's classic *Religion and the Rise of Capitalism* (1926).

The Fishmongers were, however, able to build up quite a powerful monopoly in the fourteenth century and in 1378 even refused to submit their charters to the authorities for examination for restrictive practices when ordered to do so.[18] When an order of precedence of the twelve great livery companies was established in 1516, the Fishmongers were ranked fourth, after the Mercers, Grocers and Drapers.

In sixteenth century London there appear to have been two city companies controlling the fish trade. The Stockfishmongers, incorporated by Henry VII in 1509, dealt in dried white fish, mainly cod, haddock, pollack and ling, mostly from Norway and Iceland. The Saltfishmongers, incorporated by Henry VI in 1433, handled large quantities of salted herrings, along with salted cod, whiting, mackerel and eels coming chiefly from the east coast, or imported from Holland and the Baltic. When John of Gaunt in 1378 repealed their monopoly on the grounds that it was a good thing for competition for aliens and strangers within the realm to enter the trade it was perhaps the dissatisfaction engendered which laid them open to the suspicion of collusion with the insurgents in the Peasants' Revolt; and they were even accused of responsibility for allowing Wat Tyler's men to enter the City in 1381.

On the other hand Sir William Walworth, who was Prime Warden of the Company and Lord Mayor in 1381 (and also notorious for his financial interest along with the Bishop of Winchester in the Bankside brothels) was by his treacherous stabbing of Wat Tyler at the meeting with Richard II at Smithfield Market, largely instrumental in bringing about the collapse of the rebellion. A new charter granted by Richard II in 1399 restored all their privileges, which, however, did not survive the developments of the fish trade in the fifteenth century.

The present Worshipful Company of Fishmongers was founded in 1536 by a merger of the Stockfishmongers and the Saltfishmongers. A charter of James I granted, or in all probability renewed, powers to the 'Mistery' to inspect 'any salted fish, salted Herrings, fresh fish of the Sea, Salmons, Stockfish, or any other fishes whatsoever . . . wither the fish be in cask or without cask, and to view, search and survey wither the same be wholesome for Man's Body, and fit to be sold or no.' The Fishmongers' Company, unlike many of the other great Livery Companies of the City of London has retained an active interest in the commodity to which it owes its origin and is still to this day the body responsible for inspecting fish at Billingsgate and condemning that which is unfit for human consumption. However, in those days fresh fish played only a minor part in the fishmonger's trade. With few of these merchants was fish their only or even their main interest. Thus, in the fifteenth century, Alan Johnson, a grocer and merchant of the Staple, was also a shipowner and sent two ships annually to Iceland for stockfish. He exported wool and cloth and also dealt in wine and sugar.

In a famous passage, Hamlet replies ambiguously to Polonius's denial that he is a fishmonger: 'Then I would you were so honest a man.'

Herrings for the winter and salt cod for Lent were also important commodities at England's premier Fair at Stourbridge, near Cambridge, every autumn.

THE PROVISIONING OF LONDON

London expanded rapidly under the Stuarts. The population rose from about 150,000 in 1593 by more than half a million in the course of a century. It reached 900,000 by 1801 and the 'Great Wen', as Cobbett called it, continued to grow throughout the nineteenth century. Defoe in his *Tour Through the Whole Island of Great Britain*, published 1724–26, interrupts his eulogy of the prolific sea fisheries of Essex to remark that 'almost every place of note through this whole Kingdom, as well the people, as the land and even the sea, in every part of it, are employ'd to furnish something, and I may add, the best of every thing, to supply the city of London with provisions' including fish. The fishing villages, such as Buckhaven and Fisherow, on the Firth of Forth performed the same service for Edinburgh. The new northern industrial towns that were springing up inland also required provisioning. For example, Manchester, which stood in the eighteenth century amongst barren country, obtained fish from the Isle of Man and from Yorkshire ports by pack horses.[2] Even in the time of Queen

Anne, fish was being brought from Lyme Regis to Billingsgate by relays of fast trotting horses, running day and night.[5]

Billingsgate was declared a free and open market in an Act of 1698, put into operation in the following year. Fishermen were freed from tolls, but certain dues were exacted from boats.[7] Thus every vessel with salt fish had to pay 8*d.* per day groundage and 20*d.* for the voyage; whereas every lobster boat, every vessel with fresh sea fish, and every Dogger boat or smack paid 2*d.* and 13*d.* respectively. 'Forestalling' was forbidden, fishmongers only being allowed to buy what they required for their own use and sale. Importation of foreign caught fish in foreign bottoms was prohibited with the exception of stockfish, live eels, anchovies, sturgeon, caviare, and botargo (a relish made from salted mullet roes mentioned by Rabelais), and in 1714 turbot and lobsters were added to this list of exemptions.

Most of the fresh fish sold at Billingsgate came from the small ports of the adjoining counties. Defoe writes of Barking in 1724 as 'a large market town, but chiefly inhabited by fishermen, whose smacks ride in the Thames at the mouth of the Roding, from whence their fish is sent up to London to the market at Billingsgate by small boats.' He also noted that from Canvey Island and Shoeburyness to Colchester water, Barking smacks and small boats from the coast towns sold their smaller fish locally and 'send the best and largest away upon horses, which go night and day to London market.' Folkestone, too, was 'eminent chiefly for a multitude of fishing boats belonging to it, which are one part of the year employ'd in catching mackarel for the city of London: the Folkstone men catch them, and the London and Barking mackarel-smacks . . . come down and buy them, and fly up to market with them, with such a cloud of canvas, and up so high that one would wonder their small boats cou'd bear it and should not overset.' The extreme perishability of this fish, which could not have been gutted, necessitated the utmost speed in delivery. The condition upon arrival must often have been very poor.

To improve the quality of the fish reaching London there was, in the middle of the eighteenth century, a scheme of Blake, a Westminster salesman,[16,30] for speedy transport from the coast in specially designed land carriages to supply a new fresh fish market which was to be sited at Broadway, Westminster.

This scheme never matured, but in 1762, special 'fish machines' were introduced and special privileges were granted in a Bill exempting them from toll charges, when returning empty, etc.

But, Matthew Bramble in Smollett's *Humphry Clinker*, (published in 1771) although perhaps rather jaundiced by being accustomed to 'herring with other sea fish . . . four hours after they are taken', writes: 'Of the fish [in London] I need say nothing in this hot weather, but that it comes sixty, seventy, four score, and a hundred miles by land carriage; a circumstance sufficient, without any comment, to turn a Dutchman's stomach, even if his nose was not saluted in every alley with the sweet flavour of fresh mackerel selling by retail.' The extra perishability of mackerel, which also came in large quantities from Yarmouth during the season, resulted in special permission being given for hucksters to 'cry' them on Sundays.[16] Apart from such occasional cheap mackerel, and probably herrings too, of doubtful freshness, during gluts, fish was a regular item in the diet only of the well-to-do. Thus, Arthur Young in 1771 looked upon the land carriage of fish only as a means of cheapening it for these classes. 'Did the Spittlefields manufacturers [workers] eat one pound the more? No, but the nobility, gentry, merchants and tradesmen; and . . . country gentlemen; who came to town to spend their rents, in the vain frippery of the capital, purchased it the cheaper.'

However, towards the end of the century, land carriage became quite an organized procedure. 'Luggage vans' were used drawn by four to six horses and fish carriage was put out to contract. Mail coaches were introduced in 1784 and in the next century were travelling at ten to twelve miles per hour. They were sometimes used for salmon packed in straw, or prime sea fish. It still took three days for fish from Brixham to reach London. At Leigh on the other hand, carts started the previous evening and arrived between 4 a.m. and 5 a.m. Even until about 1856, shrimps still came from Leigh to London each night by cart. The once famous Christchurch salmon was sent by coach to London.

London dominated the market for fish as for most other things. 'Only in London was the best of everything to be had', say the Torrington Diaries, and at Cheltenham 'even salmon is 7 or 8 pence per pound, owing to London's powerful indraught.'[2] At the same time a ring of fishmongers was still suspected of keeping up the price of fish there.[16] Some of the fishmongers' concerns had reached considerable proportions. In 1758, one individual owned six fishing vessels, worth £600 apiece, with crews of eight or nine, and was also an importer of fish, a Billingsgate salesman, and a retailer on a large scale.[31] He claimed to import 12,000 kits (cwts. approximately) of pickled salmon from Scotland in a year, besides great quantities of fresh salmon and from 1,500 to 2,000 salmon trout from Berwick in a week. For six months in the year he said he employed 1,300 to 1,500 men. At the other extreme, Lambeth was still a typical fishing village of small boat owners.

SALT

Salt was a key commodity in the Middle Ages. The preservation of fatty fish, such as herrings and pilchards, was entirely dependent on suitable supplies of salt and that of white fish, such as cod, only slightly less so.

Salt and fishing were connected early on as is shown by the salt works at Dieppe which, about 1030, paid an annual tax in herrings to the Abbey of St. Catherine, near Rouen.[3] There were salt pans for evaporating sea water in various parts of Britain which have left their mark on place-names, e.g. Prestonpans (originally Priest's Town) on the Firth of Forth, and Saltcoats (originally Salt cots) in Ayrshire.[32]

A part of Beccles Fen, which was on an estuary until sea walls were built at Yarmouth, is called Solfon, meaning salt pan, and was presumably used originally to evaporate sea water and produce salt for curing East Anglian herrings. In 1041 there seem to have been three salt pans at Gorleston[33] and three are also mentioned against Yarmouth in 'Domesday Book' (1086).

On the south coast where conditions were more favourable for natural evaporation during the summer, there were salt pans in the Middle Ages at King's Saltern (near Lymington, on the Solent), Bittern and Hayling Island (which is derived from the same root as 'halide').[34] The brine was boiled down in iron pans during the winter. The London Salters acquired letters patent in 1364 and were incorporated as a Company in 1395.

'Bay-salt' (named apparently after the Bay of Noirmoutiers at the mouth of the Loire),[35] made by solar evaporation in the Biscayan coastal marshes of Brittany and Gascony, and in Spain and Portugal, was long considered the best for curing fish.[2] There was early on a thriving trade in salt from Rochelle and Spanish ports, particularly with south-western English ports.[36] The province of Guyenne, north of Gascony, belonged to the English crown until 1450.

By the middle of the sixteenth century, in addition to salt pans round the coasts, particularly in the Forth and Clyde estuaries, there were also salt pans at the brine springs (*wyches*) of Droitwich (first worked as early as A.D. 816), in Worcestershire, and Nantwich, in Cheshire, where the more concentrated brine required less fuel for evaporation. By the time of Leland, 6,000 'loads' of salt per year were dispatched from Droitwich. A writer in 1562 says 'Much salt is made in England . . . in Holland, in Lincolnshire, and onely by a marvelous humor of water at the witch [Northwich] far from the sea, and in the North there is salt made at Shiles [Shields] by Tinmouth Castle . . . At Blith in Northumberland is good salt made,'[3] from sea water using outcrop coal. Salt pans on the Wear in 1589 employed 300 men, it is stated.[37] Defoe in 1724[8] noted a salt pan at Cley in Norfolk which was at one time a fishing port, now inland. Culross in Fife on the Forth was producing, also from sea water, 90 to 100 tons of salt per week in 1618 'which doth serve most parts of Scotland; some he [Sir George Bruce] sends to England and very much into Germany.'[38] Salt pans helped to destroy the English forests.[5] Camden in his *Britannia* (1601) reports that Feckenham Forest, in Worcestershire, had recently been consumed as fuel. 'What a prodigious quantity of wood these Salt works [at Droitwich] consume, though men be silent yet Feckenham Forest once very thick with trees, and the neighbouring woods, will by their thinness declare daily more and more.'

Wood was also becoming scarce owing to the needs of the navy for ships and of the iron smelters for charcoal. The salt pans therefore began to use coal and this provided about the first industrial outlet for this fuel. The Forth and Tyne areas were conveniently close to coal fields, and by the middle of the sixteenth century were competing in price with 'Bay salt'.[32] Defoe in 1724 comments that: 'The coal being thus at hand, they make very good salt at almost all the towns upon the shore of the Firth as at Seaton, Cockery and Preston.' The industries of coal mining and salt panning became closely linked. In Scotland, miners and salt panners existed in conditions of abject slavery from which they were not finally emancipated until an Act of 1799. During the sixteenth century, too, riveted iron pans began to replace the leaden ones, perhaps partly because the sulphur in the coal attacked the latter.

Soon after the Restoration, beds of rock salt were discovered in Cheshire. At first, these were mined, but when the development of the steam engine made pumping easier, the deposits were dissolved in water and the strong brine pumped up and evaporated.

The home production of salt did not meet the needs of the fishing industry, however, either as to quality or quantity. In the first place, large grained salt obtained by slow crystallization was preferred to finer salt. The reason for this is now believed to be that fine salt rapidly coagulates the surface tissues, preventing further penetration of salt into the flesh, giving rise to a condition known to the trade as 'salt burn'.[39] In the second place, there was a considerable amount of impurity in the home-produced salt as a result of the crude system of crystallization employed which impaired its properties, e.g. its flavour and its 'strength'. This is presumably due to the fact that calcium and magnesium salts, the most common impurities, are rather bitter to the palate and in addition precipitate the fish proteins and thus delay the penetration of salt into the centre of the fish. As a result, Spanish and Italian imported salt was still preferred for fish curing until modern times.[2] The Dutch, however, are said to have learnt from Cologne, the secret of purifying salt by dissolving it in pure sea-water taken from well off shore.[3] This process was introduced into Britain at the beginning of the eighteenth century. Defoe says of Bideford in 1724:

> 'The trade of this town being very much in fish, as it is also of all the towns on this coast, I observed here that several ships were employ'd to go to Leverpool, and up the river Mersey to Warrington, to fetch the rock salt . . . which . . . they bring to Biddiford and Barnstable, and here they dissolve it into brine in the sea water, joyning the strength of two

bodies into one, and then boil it up again into a new salt, as the Dutch do by the French and Portugese salt. This is justly call'd salt upon salt, and with this they cure their herrings; and as this is a trade which can be but of a few years' standing, because the rock itself has not been discover'd in England much above twenty years; so the difference in curing the fish has been such, and it has so recommended their herrings in foreign markets, that the demand for them has considerably increased.'[8]

Nevertheless, although methods of extraction of rock salt had improved by the end of the eighteenth century, a writer on the Scottish fisheries at that time still says that 'the foreign salt or bay salt is the best used in Britain for the preservation of fish . . . The broad-grained salt of that place and the Irish salt, though likewise formed from the rock salt of Cheshire, are much inferior; and our own Scots salt, made entirely from sea-water with culinary heat is still inferior to these . . . The Bay salt which is formed merely by the heat of the sun, is sharp and sweet to the taste, while the taste of Scotch salt is comparatively alkaline and bitter. The Bay salt is far better adapted than any other of the above salts for the preservation of fish, especially in a warm climate.'[40]

The end of the eighteenth century ushered in a period of heavy salt taxation, of which the effects on fish curing are described later (*see* p. 100).

TRAVELLERS' TALES

Early travellers in Asia brought back accounts of preservation there. In the latter half of the thirteenth century Marco Polo noted that the Caspian Sea produced an 'abundance of fish, particularly sturgeon and salmon at the mouths of the rivers.'[41]

In 1558 Master Anthony Jenkinson wrote to the 'Merchants of London of the Moscovie Companie' about his trip to Astrakhan, 'which this Emperor of Russia [Ivan the Terrible] conquered six yeares past [from the Tartars]: The aire there is most infected by reason (as I suppose) of so much fish, and specially sturgeon, by which onely the inhabitants live, being great scarsitie of flesh and bread. They hang up their fish in their streets and houses to dry for their provision, which causeth such abundance of flies to increase there, as the like was never seene in any land, to their great plague.'[21] The season lasted from May to August and 500 boats, some of 500 tons, passed down the Volga every year. The sturgeon were salted with natural salt along the shores of the Caspian Sea. In 1588, Giles Fletcher, Doctor of Civil Law, ambassador from Her Majesty to the Emperor Theodor says 'of cavery [caviare] a great quantitie is made . . . of the roes . . . the most part shipped by the French and Netherlandish merchants for Italy and Spaine.'

At Ormuz, at the entrance to the Persian Gulf, the Polos found that the people 'live chiefly upon dates and salted fish, such as the thunnus [tunny], "cepole" and others which from experience they know to be wholesome . . . for were they to eat wheaten bread and flesh meat their health would be injured.' On the coast of Oman, too, 'the inhabitants . . . subsist upon dates and upon fish, either fresh or salted, having constantly a large supply of both; but persons of rank . . . obtain corn from other parts.'

On the arid coasts of the Arabian Sea, fish were still as important as when the Greeks termed the inhabitants *Ichthyophagi*. Islands near Socotra yielded 'an immense quantity . . . Both when fresh taken and when salted, the fish are sold to the traders resorting to the island.'

Near Aden fishermen 'catch the tunny in such numbers, that two may be purchased for a Venetian groat. They dry them in the sun.' Since there was no vegetation 'they accustom their cattle, cows, sheep, camels and horses to feed upon dried fish . . . of a small kind [possibly anchovies] which they take in vast quantities during the months of March, April and May; and when dried, they lay up in their houses for the food of their cattle.* They will also feed upon fresh fish but are more accustomed to eat them in the dried state. In consequence also of the scarcity of grain, the natives make a kind of biscuit of the substance of the larger fish, in the following manner: they chop it into very small particles, and moisten the preparation with a liquor rendered thick and adhesive by a mixture of flour, which gives to the whole the consistency of paste. This they form into a kind of bread, which they dry and harden by exposure to a burning sun.' Herodotus (v: 16) described much earlier how the lake-dwellers of Lake Prasius (now called Lake Takino, in Thrace) fed their horses and other beasts upon fish. Another classical writer described the *Ichthyophagi* of India whose 'cattle taste like fish . . . for they are fed upon fish.' Evidently geographical difficulties had prevented technical advance for twelve centuries or more on the Arabian coast.

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* To this day fish are dried in the same manner on this coast and exported for manure, as well as being used for camel feed.

In China in the time of Marco Polo, the fish industry was highly developed and well organized. Fresh fish was obtained from the sea, rivers, and lakes, the waters of the latter being fertilized. Fish ponds had been artificially stocked, using spawn, since 500 B.C.[42] At Hangchow 'from the sea, which is fifteen miles distant, there is daily brought up the river, to the city, a vast quantity of fish; and in the lake also there is abundance, which gives employment at all times to persons whose sole occupation it is to catch them. The sorts are various according to the season of the year, and in consequence of the offal carried thither from the town they become large and rich. At the sight of such an importation of fish you would think it impossible that it could be sold; and yet in the course of a few hours it is all taken off, so great is the number of inhabitants, even of those classes which can afford to indulge in such luxuries, for fish and flesh are eaten at the same meal.'[41]

The Chinese seem to have invented the reel as an aid to fishing, since it is first depicted in use in one of their paintings dating from about the thirteenth century.[28] It is also shown about the same time in an Armenian parchment gospel representation of St. Peter casting a hook (St. Matthew XVII: 27). This was an important invention and George Sarton, the historian of science, comments: 'The lives of many men depended on fishing and the reel was a material improvement.'

Although only fresh fish is mentioned, there was a considerable salt industry in various parts of China in the days of Marco Polo. It was 'the principal commodity' conveyed on the Yang-tse-Kiang River system. It was commonly made by solar evaporation in salt marshes and lakes. There were salt springs in Yunnan from which salt was procured and used for pickling meat and presumably also the fish which was caught in quantities in the lakes. Near Ho-Kien, north of the Yellow River, 'is found a salsuginous earth; upon this, when laid in large heaps, they pour water, which . . . is then collected in channels, from whence it is conveyed to very wide pans, not more than four inches in depth. In these it is well boiled and then left to crystallise. The salt thus made is white and good, and is exported to various parts. Great profits are made by those who manufacture it, and the Grand Khan derives from it a considerable revenue.' At a later period, the Chinese seem to have been the first to use ice for the preservation of fish[43] (*see* p. 215).

Practices in the New World were quite primitive. Hakluyt recounts that Henry Hawks in 1572, on a voyage to New Spain (Mexico) observed that 'they have a great store of fish in the South Sea and many oisters and very great. The people do open the oisters and take out the meat of them and dry it as they do other kinde of fish and keep it all the yeare; and when the times serve, they send them abroad into the country to sell as other fish.'[21]

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Chapter 3

SALT PICKLED HERRING

The herring and the cod were in the Middle Ages, as now, the two most abundant and important species of sea fishes available to the Western World. Their fisheries were always practically separate and distinct, although equally important. Just as salt cod became known as the 'beef of the sea', pickled herring would have had an equal right to have been called the 'pork of the sea' on account of its fattiness. However, this name had already been reserved for the porpoise (i.e. 'porc-poisson', or 'pig-fish'). Whereas white fishes, such as cod, contain practically no fat, and therefore lend themselves readily to a simple and effective cure merely by salting and drying in the sun, herring subjected to a similar process would soon become objectionably rancid in flavour. This is because its fat is, chemically speaking, relatively 'unsaturated', and readily combines with atmospheric oxygen, in the same way that linseed oil 'dries', i.e. is oxidized too, when it is used in paint. For this reason the characteristic methods developed for preserving herrings, and similar seasonal, surface-shoaling, migratory or pelagic species, were salting and covering with brine in tight barrels—which minimizes access of oxygen to the fish—and smoking. The latter process also lessens oxidation of the fat by reason of the absorption of some of the tarry, phenolic substances produced during the combustion of wood, which possess so-called 'antioxidant' properties. Although herrings were also sun and wind dried without salt, and still are in Iceland, such products must rapidly have become very rancid and were articles of local consumption only. Only heavy salting and smoking, which seems to have been the earlier process, resulted in products which were stable enough to be traded safely by the slow moving sailing ships of the time.

The herring is a fish which shoals seasonally in enormous numbers in the North Atlantic, but is unknown in the Mediterranean, so that it was not prominent until the emergence of feudalism in western Europe. It is a particularly perishable fish so that any record of it in early times almost necessarily presupposes methods of preservation. As early as A.D. 709 herring appears in the accounts of the monastery of Evesham,[1] being carried inland by pack horse. Norwegian sagas of the end of the tenth century also refer to herring. It is even suggested that the fluctuations in the availability of herrings, which occur from time to time for natural reasons with these migratory species, were responsible for the migrations of the Vikings who were poor agriculturalists and lived chiefly on a fish diet.[2]

There is documentary evidence that the coasts of the North Sea and Baltic were centres of activity at an early period. Thus, there is a record of 'piscatores Angliae, Galli et Belgae' at the mouth of the Yare in the sixth century, and in A.D. 647 a church at Yarmouth was dedicated to St. Nicholas, the patron saint of fishermen.*

Herrings must therefore have been caught off the coast of East Anglia even before the existence of the sand bank that became the site of Yarmouth. There were, significantly, several salt pans in the area (*see* p. 45). Beccles, then on the estuary, paid a rent of 30,000 herrings to the Abbey of St. Edmund at the time of Edward the Confessor (1042–65). This was doubled by William the Conqueror. Dunwich paid 6,000 and Kessingland, also in Suffolk, 22,000, while on the south coast, Brighton paid 4,000.[4] Norwich, too, had at one time been a fishing port, but by the time of William of Malmesbury (1152) had ceased to be one. Yarmouth itself was an important borough at the time of Edward the Confessor, with a prosperity dependent on the herring. It held a Free Fair from Michaelmas, 29th September, to Martinmas, 11th November, even before the Conquest. It was made a free city in 1194 and was granted a Charter by King John in 1208, which gave foreign merchants permission

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* Incidentally, it may be no coincidence that St. Nicholas, also the patron saint of children as Santa Claus, was associated with salt pickling by a typical Medieval transformation. On account of his zeal for baptizing pagans in Asia Minor, St. Nicholas, who died in A.D. 326, was commonly represented beside a font in which there stood three naked pagans. The saint, by convention, appeared larger in stature than the other actors, so that as time went on the latter were mistaken for boys. Then the round font became a pickling tub and a legend was invented about three murdered, dismembered boys served up to him as a meal at an inn, and miraculously restored to life after divine warning.[3] Parts of the present parish church of St. Nicholas at Yarmouth date from the early fourteenth century, when building was interrupted by the Black Death (1348).

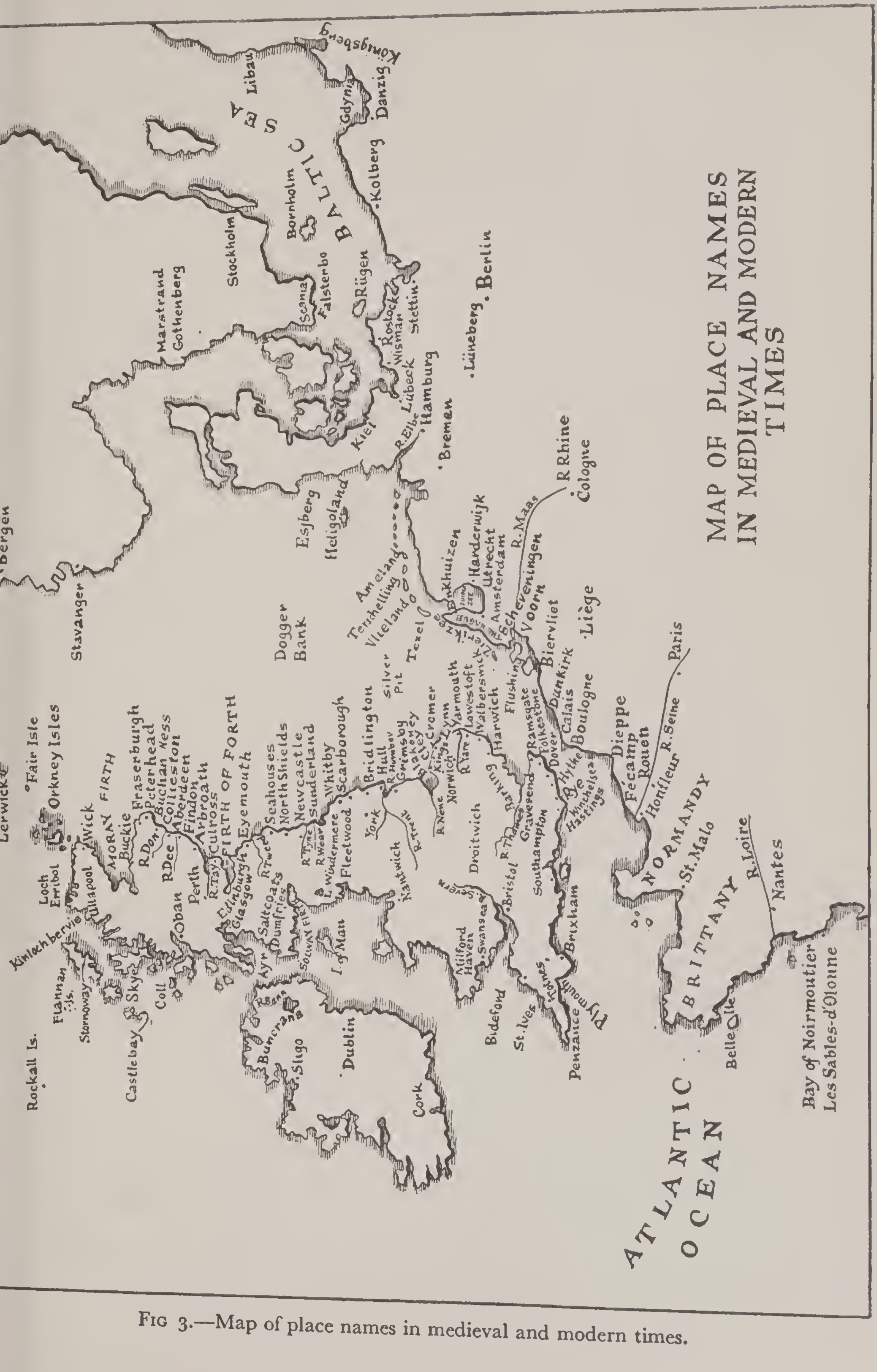

Fig 3.—Map of place names in medieval and modern times.

to come and buy herrings. At that time Hastings fishermen used to travel to Yarmouth every season in their square-rigged rowing boats for the herring season; and the men of the Cinque Ports acquired certain rights there. In the next reign, that of Henry III, Yarmouth first became known as Great Yarmouth, and although later Lowestoft challenged its monopoly, it never equalled Yarmouth in importance.[5] When Henry III's daughter, Princess Margaret, married the Duke of Brabant, they took home 10,652 herrings, together with 292 cod and 2 barrels of sturgeon.

There were also fisheries off Devon and Cornwall and the Yorkshire coast. Alexander Neckam, Augustinian prior of Exeter, who died in 1227, sang the praises of herring. In 1240 the monks of the Cistercian Abbey of Meaux, near Hull, were granted half an acre of land for the erection of store houses for herrings and other fish. By the middle of the fourteenth century, their plenitude and cheapness resulted in 'the consumption of herrings being all but universal, even in the inland counties of England.'[6]

In Scotland, David I, in 1153, issued an edict that all goods brought by sea should be landed prior to sale with the exception of salt and herrings, a significant combination, which might be sold on board the vessels. The Scottish Parliamentary Records for 1240 refer to fresh and dried herrings. Herrings were therefore being caught and preserved practically all round our shores.

Across the Channel, herrings were caught off the coasts in the time of Charlemagne (742–814) and there is mention of them at Fécamp, Calais and Dieppe in 1030. Louis VII in 1155 prohibited his subjects from buying anything but mackerel and salted herrings at the market of Estampes. There is a similar mention in 1179[7] and a charter of 1187 granted to the inhabitants of Liège the privilege of dealing in fresh and salted herrings.

The Netherlanders also at this time were active in the herring fishery of the North Sea. In 1177 Margaret of Alsatia, Countess of Flanders, issued a regulation prescribing the manner of salting herrings.[8] They were fishing off Yarmouth in 1295 when Edward I '. . . understood that many people from Holland, Zealand and Friesland, who are our friends, will shortly come and fish in our sea off Yarmouth.' They must have preserved their fish at sea on board the ships.

In the Baltic, there was in 1054 a fishing for herrings off the coast of Denmark in the Sound twice a year, and those who engaged in it carried on a trade with Bremen for salt.[9] In 1120 herrings were fished plentifully along the coast of Pomerania.

The industry in the Baltic was chiefly concentrated at Scania (or Schonen), first mentioned in 1180, with its two fishing villages, Skanör and Falsterbo,[10] on the extreme south-western tip of Sweden, which was actually Danish territory until the seventeenth century. Fishermen from Kampen and Harderwijk, on the Zuider Zee, were also fishing in the Baltic 'off Scanen' before the end of the twelfth century, and even in 1418 the Dutch curers still preferred Scania herring.

There were also fisheries off the island of Rügen and the Pomeranian coast, near which were salt springs. Kolberg was famous as a market for salt herrings in the twelfth century. Lübeck fishermen 'lay with their vessels at Skanör, at the herring fishing' as early as 1201. In 1236, such immense quantities of herrings were caught off the German coast that the surplus had to be boiled down for oil, as was usually done with the waste.

IMPROVED METHODS OF SALTING HERRINGS

Thus, salt herrings were widespread in Western Europe by the twelfth century. The product was not, however, what we now know as salt herrings, but was probably merely ungutted herrings sprinkled with salt in irregular heaps on the ground to prevent putrefaction, and it could not have gone far beyond the necessities of slow transport home followed by immediate distribution and consumption. But as the historian of the Dutch Sea Fisheries comments: 'There is an immense distance between packing or strewing fish with salt so as to preserve them for a short time and curing them so as to last for years and become an article of trade.'[8] The Dutch were associated with improved methods of salting culminating in important discoveries at the end of the fourteenth century. The fishermen of Zierikzee on the East Schelde, seem to have been the first to pack herrings in barrels* at sea and those of Biervliet, on the West

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* A herring barrel filled with stones is reported to have been used with devastating effect at the siege of Melun, on the Seine, in 1359.

Schelde, in the southern part of Zeeland near Vlissingen (Flushing), were the first to clean the insides of the fish in order to preserve them better.

A Yarmouth man, Peter Chivalier, salted herrings caught off the south-west coast by an improved method and held the King's licence for a monopoly.[1] Peter de Ferars of Cornwall gave the King 20 marks (a mark was 13*s.* 4*d.* which was worth much more then than now, of course) in 1221 for a licence to salt herrings according to this method, and repeated the payment in subsequent years.

THE HANSA

The Hanseatic League of merchants of the North Germanic towns owed much of its trade to Baltic herrings, and by the beginning of the fourteenth century was establishing control over Scania, which remained for several centuries predominant in the salting of herrings.

In the early days the bulk of the fish was made into 'red', smoked herrings or *Bückling* (*see* p. 284), but large quantities were also pickled. Quality was subject to strict regulation. Salting and packing was done by women under the strict supervision of curers,[11] and 'gutting-women' were mentioned in 1494. After gutting, the fish were washed in sea-water, 'roused' in salt and finally packed with salt in barrels. The barrel, when full, was allowed to stand ten days, after which the herring had sunk a little, so that the barrel was re-opened and filled. Hanseatic laws forbade the placing of small or inferior fish in the middle of the barrel and the fish had all to be salted alike and packed in regular layers. At first they were exported in the barrels in which they were originally packed, but later on the majority were sent to the Hanseatic towns to be sorted and repacked in specially stamped barrels. In 1375 at a conference at Lübeck, the 'Rostocker Band' was selected as the standard measure. 'Full' herring were distinguished from 'spents' and those from Scania from those caught farther up the coast at Marstrand. Each great Hansa town, Lübeck, Danzig, Stettin, etc. had its own area marked out on the Scania peninsula. Kolberg's, for example, occupied 480 yards by about 100 yards. Here the merchants camped and transacted their business during the season, and here the salting and packing of the herrings took place.

Salting was forbidden on the foreshore or on the fishing boat. Each town, too, had its own special brand. Lübeck, which was the most important town of the League, had three herrings on its coat of arms, just as Yarmouth also had at one time.

The Hanseatic merchants used mostly local salt, e.g. from Lüneberg, in Saxony, for salting the Baltic herrings, largely because it was cheaper than salt imported from ports on the Bay of Biscay, of which, however, they bought occasional cargoes.

Britain imported herrings from the Hansa. A Proclamation of 1382 refers to conditions for the sale of herrings from 'Scone' (Scania), 'Jernemouthe' (Yarmouth), 'Holy land' (Heligoland) and 'Sounde' (between Denmark and Sweden). Hakluyt[12] gave details of 'An agreement between King Henrie the fourth and the common societie of the Merchants of the Hans' in 1405, with a supplement detailing damages sustained by English merchants and seamen, principally of Cley, at the hands of the citizens of 'Wismer' and 'Rostok'. These invariably involved 'lasts of herrings' or 'salt fishes' or sometimes salmon. A 'last' was ten, twelve or sometimes fourteen barrels, numbering 10,000 nominally, but actually 12,000 or even 13,200 herrings, and weighing about two tons.

The Hanseatic merchants did not actually work; they only traded. They sold fish in Germany itself, Russia, Poland, the Baltic lands, Flanders, France, Spain and Portugal as well as Britain. They also controlled the mineral wealth of Sweden and the fur and fish trade of Norway (*see* p. 122). A Hanseatic law of 1412 decreed that no ship was to be built with a greater capacity than 100 last (200 tons).[13] These dimensions were, of course, exceeded later as the art of shipbuilding improved. Baltic herring and Norwegian stockfish were the principal commodities carried in barrels by the last.

The fishing boats themselves had a capacity of up to twelve lasts (24 tons) and were equipped with both sails and oars, but were undecked so that they had to fish close to land and returned to harbour daily. They carried three to six men and fished with either drift- or set-nets.

The fair at Scania appeared to last from 25th July until 29th September although the period from Our Lady's Nativity (8th September) to All Saints' Day (1st November) is also mentioned, and in the sixteenth century it was from 15th August to

9th October. The size of the industry may be gauged from the fact that in 1463, 20,000 men are reported to have been involved in a free fight between Danes, who fished, and Germans, who did the curing.

The fishing, which was a profitable source of revenue to the Danish King, was irregular, some years being extraordinarily successful, followed by long intervals when the herring entirely disappeared from the coast. It is reported that in the second quarter of the fifteenth century, the herring ceased to spawn in the Baltic and the centre of gravity shifted to the North Sea. This contributed to the decline of the Hansa and the advantage went to the Dutch and English, although 34,000 barrels were cured at Scania in 1368 and 50,000 in 1494; and even in the sixteenth century, fish was still being cured in the Baltic in large quantities.

THE DUTCH

The improved method of salting (*kaken* cf. French *caquer**) with which the Dutch were able to exploit this advantage, is attributed to William Beukels or Beuzelzoon. There are several variants in the spelling. Some even claim that he was an Englishman named Belkinson. His dates are also uncertain: 1347, 1387, 1397 and 1401 have all been mentioned, either for his birth or death, thus introducing an uncertainty of at least a century. Many volumes have been written about Beukels. Some even dispute that he ever existed, or that if he did he made any improvements in the methods of herring curing. However, it is quite certain that soon after his reputed dates the Dutch herring acquired a reputation in the European markets which those of no other country could hope to rival.

There were many sixteenth-century accounts of the Dutch invention attributing it to Beukels, of which that of Jacques Marchant of Nieuport (1537–1604) in his *Flandria descripta* (Antwerp, 1596) says, under the entry for 'Biervlietum' 'Domicilium hic fixit et morte refixit anno 1347, Guillemus Bouclensis, inventor artis stipend; condiendique haleces in cadis salsamentarius.' Heylen (1737–93) in 1786 refers to a curious remark of

*The stronghold of *Cacques* (or 'Herring-barrel'), along with *Château Salouoir* (or 'Salting-tub'), was a bone of contention between the 'Chitterlings' (i.e. sausages) and 'King Lent' in Book IV of Rabelais' *Gargantua and Pantagruel* (1552).

Schreger in 1749. 'Artem condiendi haleces et intonnis conservandi primus excogitavit Wilhelmus Boeckel é Belgio piscator anno 1416, unde hi pisciculi vocantur Boekelheringe.' Sarton comments:[14] 'This is fanciful etymology; the words *Pökelhering* in German, *pekelharing* in Dutch and 'pickled herring' in English are constructed from the verbs, *pokeln*, *pekelen* or to pickle, derived from the same root which must be an ancient one. It is a strange coincidence that the name Beukels seems to belong to the same root.'* He goes on to point out that 'The invention was a complex one for it implied many operations, each of which could be done in many ways, and was susceptible of gradual improvements.' Thus, the invention like many another, might be and was made in many steps; hence the credit for it should be shared by many ingenious men engaged in that profession and able to understand its needs and to help in their fulfilment. The invention may even have occurred partly or completely to many men engaged in the herring industry. To measure Beukels' achievements, one should know more exactly what he did, and that is impossible. Finally, it is always difficult to distinguish between an invention and the industrial and commercial exploitation of it. 'It is the invention itself that matters, not the man who made it, but the millions of men whose life was made a little sweeter because of it.'

Sarton chooses the invention as a type example of how technical inventions spread in spite of illiteracy so as to overcome every kind of geographical and political frontier.

The latest historical research into the position of Beukels, accepted by Sarton, is that the new industry originated in Scania which, as already indicated, was salting herring in a large way long before the Dutch. The *Oosterlingen* (or Easterlings† as the Hansa merchants were called), are then supposed to have brought the industry to Zwin, near Bruges. In this way the herring industry was established in Flanders before 1375. Gillis Beukels of Hugevliet (near Biervliet) definitely took a leading share in it, dying in 1397. The Flemish authorities at first

* It is a still more extraordinary coincidence that the Germans have a smoked herring called *Bückling* (*see* p. 284). 'Pickle-herring' also came to mean a clown, through the German in which it was the name of a humorous character in an early seventeenth century play, and of the chief actor in a series of 'Pickelhärings-spiele'. Addison in the *Spectator* for 25th September, 1711, uses the term 'Pickled herring' as synonymous with a merry-Andrew.

† Hence, possibly, 'sterling', a tribute to the reliability of their coinage.

discouraged the new industry, between 1395 and 1398, and began to encourage it only after about 1419.

The details of the new process were enforced by minute and precise Government regulations and restrictions which for a long time ensured the supremacy of the Dutch cure. Immediately after the herring had been shaken out of the drift net they were 'gipped' by removing the gills and some of the viscera including the long gut, through an incision in the throat; sprinkled with salt and 'roused', i.e. turned over and over; sorted and packed head to tail in barrels with salt sprinkled between the layers, which were arranged alternately across each other (*see* Fig. 4). Finally, the barrels were topped up and made airtight (to minimize oxidative rancidity) and branded with the date of catch. Exactly the same process is still used to-day. Although in this country the process is carried on at the port instead of on the ship, the Dutch vessels fishing off East Anglia in the autumn still salt at sea. Keeping the fishing fleet at sea, of course, considerably reduced the cost of production, compared with making long journeys to their home ports. The invention made it possible to distribute fish to distant places by land and water, and this revolutionized the economic condition and even, it is claimed, the history of Europe, the Dutch being the main beneficiaries.

In this pickled form, herrings could be shipped safely to the mouths of all the principal rivers in Europe from the Vistula to the Seine, but chiefly the Rhine, Meuse and Scheldt, up which they were conveyed for interior distribution.[15]

Whatever part Beukels played in this innovation, his tomb seems to have been honoured by his countrymen. There is a story that the 'Holy Roman Emperor' Charles V visited his tomb on 30th August, 1556, together with his two sisters, Eleanor, dowager queen of France, and Mary, dowager queen of Hungary, Governess of the Netherlands. There is no documentary evidence of this, but Sarton points out that the story is plausible since soon after his abdication, Charles visited Ghent and Zeeland and sailed from Flushing on 17th September for his final voyage to Spain. The tomb still existed at the end of the seventeenth century, but has now disappeared, together with a good part of the town, gradually reconquered by the sea.

The Grand Fishery on which Dutch supremacy was based for several centuries was prosecuted off the shores of England and Scotland. Quality was maintained by stringent regulations as to mesh size, the quantity and type of salt used, the time and place of fishing and the fabrication and branding of barrels, etc. John, Duke of Bavaria and Count of Holland, issued such regulations in 1424.[8] The barrel of Brielle in the north-west corner of the island of Voorn was adopted as the standard. Systematic legislation was inaugurated by a law promulgated in 1519 by the Emperor Charles V. The Dutch Republic consolidated the regulations and in 1620 the College of Fisheries was invested with full powers to make regulations and settle disputes. This College met annually at Delft at the commencement of the fishing season to issue instructions and grant licences.

Curing was permitted only from 1st July to December, although in some years there was an earlier start, e.g. 24th June (St. John's Day) in 1588, 1593, and 1620, or even 1st June in 1586. This variability was probably to take account of natural variations in the movements and condition of herring from one season to another: before the appointed date they would probably not have been fatty enough. The first cast of nets was made at 'Hitland' (Shetland), 'Phayril' (Fair Isle?) and 'Boekenes' (Buchan Ness) and fishing continued until 25th July. Herring caught before St. James's Day (15th July) were packed separately, possibly because they were excessively soft and oily. After 25th July fishing continued off Buchan Ness and farther south until Elevation Day (14th September). In the autumn they fished off East Anglia.

September 21st was known as Dutch Sunday in Yarmouth on account of the celebration of rituals, e.g. 'Washing the nets', similar to the present-day service of 'blessing the nets', in preparation for fishing. The Dutch fished in the vicinity of Yarmouth until St. Catherine's Day, 25th November. Christmas saw the fleet working off the Thames estuary and they then returned to Holland to refit.

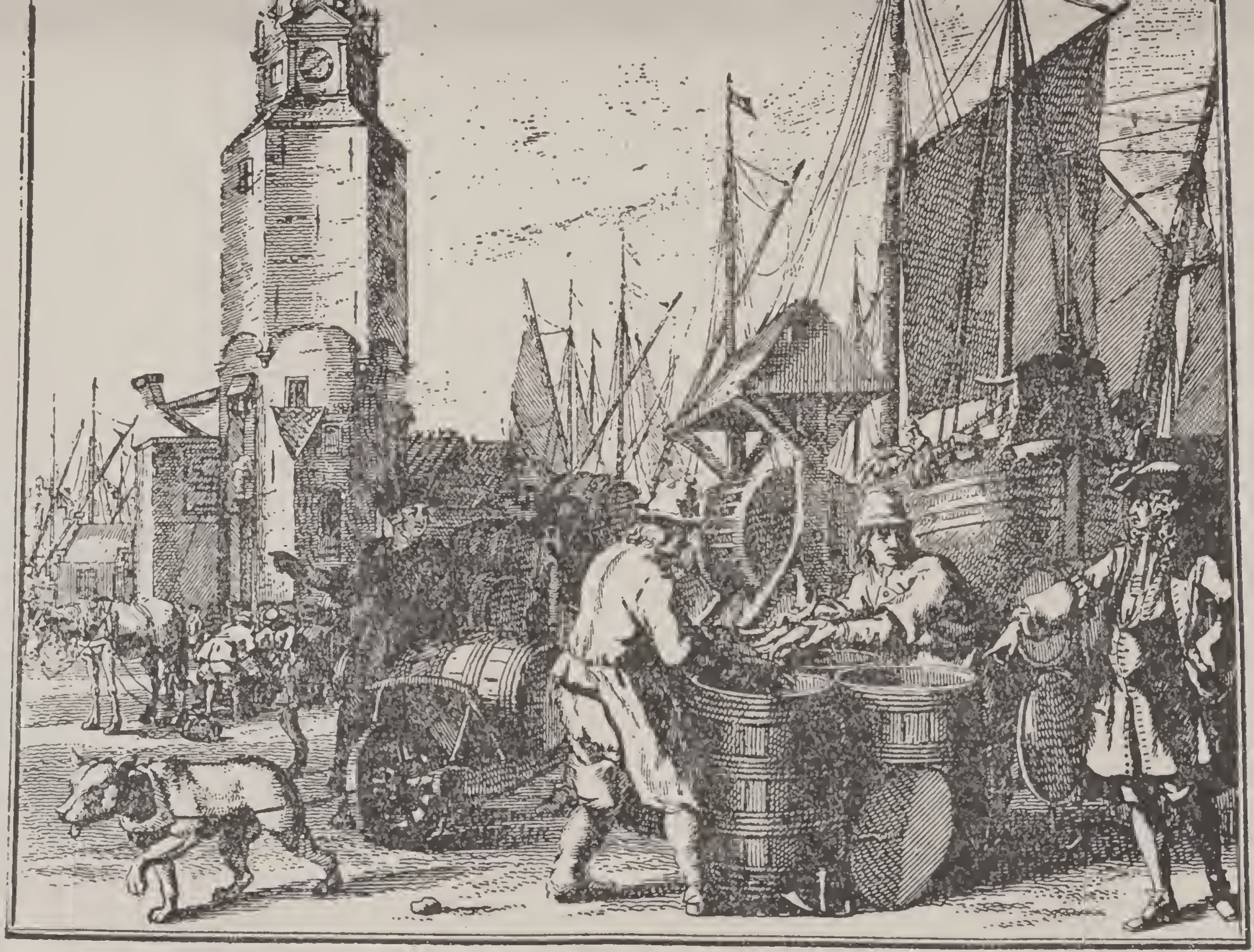
It was forbidden to fish among the cliffs of Shetland, Iceland and Norway, because the herrings were said to be inferior and unfit for curing, although another reason may have been to avoid political complications with James I, etc. Herrings caught in the Zuider Zee, which were generally of inferior quality, were not allowed to be salted or exported, but had to be kept for home consumption and were usually smoked as *bokking* (*see* p. 73).

Once caught, the fish had to be carefully disposed in the barrels in regular layers and on no account were to be poured out of the basket into the barrels in heaps. Herrings of different quality had to be kept separate. All herrings had to be brought back to Holland for branding and could not be sold at sea or taken direct from the fishing grounds to foreign markets. First caught herrings could not be sold until they had been in the pickle for at least ten days, on pain of a fine of 300 guilders or confinement on bread and water for a month (1651). The repacking on shore had to be completed within three weeks of landing (1636) (*see* Fig. 4).[16] Whilst the ship was still at sea, herring already barrelled were to be 'pickled', or moistened with sea-water every fortnight, and according to one writer this was the origin of the name 'pickle-herring' for fish salted at sea.

The number and size of staves for making barrels were specified and not more than three pieces of wood were allowed in the bottom of the barrel. Only dry, heavy wood could be used and faulty barrels were broken up. The use of old barrels for curing herring was strictly prohibited.

In the law of 1519, the salt used for the Dutch-cured herrings was all supposed to be 'moor-salt' made from the salt impregnated turf (*darinck*) of estuaries, Zierik Zee, etc., which was covered by the sea at every tide. This was burnt and refined by moistening with sea-water to dissolve away impurities. Four barrels of 'moor-salt', equivalent to 5½ barrels of 'salt sodden with salt' (*see* p. 47), were to be used for each last of herrings. 'Lisboa salt' was excluded, although by 1580 there is no further mention of 'moor-salt' and only Spanish or Portuguese salt was admissible. The proportion of salt mentioned, which corresponds to a ratio of about 1 : 3 of fish, would be expected—allowing for wastage in the brine—to result in roughly a saturated solution of salt (about 26 per cent) in the liquor in the tissues of the fish, which is now known to be essential for proper keeping.

This fishery necessitated the development of a deep sea herring-fishing boat, suitable for the process of salting at sea away from the home port, of which there is record as early as 1410. The herring 'busses' evolved at this time to meet this need were


The Packing of the Herrings into the Barrils

By courtesy of John Murray (Publishers) Ltd.

FIG. 4.—The Packing of the Herrings into the Barrils. *From* The Herring *by A. M. Samuel.*

large, seaworthy, three-masted, decked ships usually of 80 to 100 tons burden. They were very full in the body at the waterline, the keel being only about fifty feet and the beam fifteen to seventeen feet, and they had a narrow high poop. They normally carried and had accommodation for fourteen to fifteen men, including skilled picklers and coopers to make the barrels tight. Their capacity was normally about thirty-five lasts, although larger vessels of up to 200 tons, had a crew of thirty and could hold nearly 100 lasts. The first busses were built at Hoorn and Enkhuizen in 1416 and the first large herring drift gill net, also made at Hoorn at the same time, was 50 to 60 fathoms in length. By the middle of the century the whole of the province of Zeeland seems to have provided itself with these larger herring busses, although the smaller vessels were not completely replaced and, in fact, continued to accompany the busses to the fisheries. These ships had to run the gauntlet of pirates and privateers and were therefore usually armed and frequently convoyed by warships.

The high prices fetched by the first herrings of the season led to great eagerness to reach the market. Special swift *ventjagers* ('sale-hunters', or, perhaps, 'wind-yachts') were used as tenders to rush the first-caught fish of the season to Holland to be branded and away to markets such as Hamburg. They were first mentioned in 1556, but obviously did not then proceed beyond the river mouths. By 1602 they were accompanying the herring fleet, one to each ten busses during the first part of the season. After 25th July, no tenders were allowed.

In ordinary circumstances, the herrings were conveyed in slow-moving wagons and canal boats, but when the first *jagers* arrived at the Dutch ports they were met by fast-trotting horses in light gigs capable of carrying a few barrels of herring only. The fish was then raced to the chief markets where the town crier announced the new season's herring and flags were hung out of the houses.

An early seventeenth century pamphleteer, 'Tobias Gentleman' in *England's Way to Win Wealth* (1614) describes the Dutch 'gallant Fleete of Busses' setting out to begin fishing in Shetland. 'Now if that it happen they have so good a wind to be at Shotland before the 14 day of Iune, then do they put . . . into a sownd called Braccies Sownd, and there they frolicke it on

Land . . . but the 14 day of Iune being come . . . the first day by their owne law, before which time they must not lay a net for vntill then the Herrings be not in season, nor fit to be taken to be salted.

'From this place, being nigh two hundred leagues from Yarmouth, do they now first begin to fish, and they do never leave the Skoales of Herrings . . . lading their ships twice or thrice, before they come to Yarmouth . . . and sending them away by the Merchant ships that cometh vnto them, that bringeth them victuals, barrels and more salt, and Nets . . . the which Ships that buyeth their herrings they do call Herring-Yagers, and these Yagers carry them and sell them in the East Countries . . . Now besides this greate Fleete of Busses the Hollanders have a large number more of smaller Burthen onely for to take Herrings also . . . from fifty Tunnes vnto thirty Tunnes and twenty Tunnes . . . and they bee called some of them Sword-pinks, Flat-bottomes, Holland-Toads, Crabskuits, and Yevers, and all these, or the most part doe goe to Shotland, but these have no Yagers come into them, but they go themselves home when they be laden, or else vnto the best Market: There have been seen and numbred of Busses, and these, in boraces sound and going out to Sea and at Sea in sight, at one time two thousand Sailes, besides them that were at Sea without sight, which could not be numbered.'[17]

The packing of bad herring together with good herring was severely prohibited, but bad herring could still be packed separately if correctly labelled, e.g. *nachtshamel*, i.e. 'overdays'; *kuytsieck* or *melksieck*, i.e. 'ripe-running'. *Stanck ofte want haring* meant 'stinking or strong buttery', i.e. presumably, rancid herring.

No one, according to a Placart and Ordinance of 1651, should lay the herring cross-wise, or falsify or change them, put the old under new, lay those bitten by sharks (dogfish), or that were sickly, by the good, nor those which were caught on the one night by those of another taking. No herring could be 'heightened' by fresh pickle nor repacked but in the public street,on the quays or in 'such places as are customary with open doors.'

Fat early herrings kept better at sea than on shore owing to the motion of the ship keeping the brine in circulation, it was claimed; it seems more likely that the lower temperature at sea was responsible. The later fish caught after Michaelmas (29th September) off East Anglia, when washed clean in their own pickle and repacked in fresh salt would keep for twelve months in any climate in the world.[15]

With their superior product, the Dutch ousted the Hanseatics as purveyors of salt fish to France, Flanders and Britain. An English book published in 1436 catalogues the 'Commodities of Brabant and Zealand' in verse as follows:

Madre and woade . . . garlike and onyons,
And salt fysche als for husband and comons.

The Flemings who at one time had a thriving fishery, were forced out of the trade until, by the middle of the sixteenth century, they scarcely caught enough for their own consumption.

At the beginning of the seventeenth century the Dutch began to conquer the German and Baltic markets.

Sir Walter Raleigh estimated in his *Observations Touching Trade and Commerce with the Hollanders* (about 1610) that they had 3,000 ships and 50,000 people employed in the fishery about the British coast. John Evelyn, the diarist, in 1674, put the figure at more than 7,000 vessels. These estimates were almost certainly exaggerated, but there must have been more than 1,000 busses fishing about 1560, which grew to 1,500 in 1610, 2,000 in 1620 and perhaps even more a little later. Enkhuizen alone had 700 in 1637. Each buss commonly made three voyages between St. John's Day and December, bringing back about forty lasts in a season, i.e. about 400 crans, after which ship and gear were worn out. This catch can be compared with the average of 845 crans caught by English steam drifters during the first seven weeks of the East Anglian season in 1936, a typical year.[18] In 1614, the Dutch are reported to have exported 74,000 lasts (about 150,000 tons) at a price of £20 to £30 a last, of total value about £1,500,000. It was estimated fairly reliably that in 1669 there were 30,000 fishermen and that with the ancillary trades of curing, and the making of casks and nets, 450,000 people were employed—or about one-fifth of the population. It used to be said, figuratively, that Amsterdam was 'built on herring bones'. As one Calvinistic Dutch writer puts it in 1639: 'The Dutch catch more herrings, and prepare them better, than any other nation ever will, and the Lord has, through the instrument of the herring, made Holland an exchange and staple-market for the whole of Europe.'

In spite of the superiority of the Dutch cure, production of salted herrings continued in this country, although the Yarmouth cure only fetched £10 per last when the Dutch cure sold for £25 per last. The Southampton port books for 1427–30 show that there was a large coastwise trade in salted herrings, chiefly from Covehithe, Southwold, Dunwich, Lowestoft, Orwell and Walberswick in Suffolk and Great Yarmouth, Cromer and Cley in Norfolk, although Newcastle, Easton (near Portland) in Dorset and Penzance are also mentioned. The total import in 1430 was 2,590½ barrels (about 500 tons). The quality of the product was often indifferent. There is an instance of a fishmonger who bought herrings which proved, when the barrels were opened, to be so bad that when he gave them away to the poor in cheap generosity, they asked if he wanted to poison them and 'dyd cast them at his head agayne.'

Attempts were made to improve the pack along the lines of the Hanseatics and later the Dutch. Thus, in 1482 Parliament ordered that herring packed in barrels were to be fish all caught at the same time, salted at one time and as good and well packed in the middle of the cask as at the ends. The magistrates of various towns were required to provide inspectors to superintend the packing in order to prevent mixed or inferior fish from being sold as prime herring, to the detriment of our markets. A sixteenth-century print representing a man packing herrings in a barrel, shows them with a gap at the throat, indicating that they must have been gutted.[4] Again under Charles II, in 1663, it was ordered that the barrels should be of good quality. The Bailiff at Great Yarmouth had to see that 'able and experienced packers were provided.'

Subsequent attempts to control and improve the quality of salt-cured herrings, associated with a succession of attempts to encourage the establishment of a British industry, are described in Chapter 5 (p. 90 *et seq.*).

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Chapter 4

RED HERRINGS, BLOATERS, PILCHARDS AND SALMON

RED HERRINGS

THE technique of smoking herring seems to have been improved at Yarmouth, where the 'red herring' was developed about the beginning of the fourteenth century, i.e. probably even before the improvements in salt pickling described in Chapter 3. Long before this, herrings were being preserved by some form of smoking. An ordinance of 1230 shows that the Abbey of Fécamp had the custom of giving one or more trees from a wood to the poor for the smoking of herring.[1] An Act of Philip V of France in 1320, shows that Paris had both 'white' (i.e. pickled*) and smoked herrings. An English will dated 1349 mentions fish houses, including a 'black house' used for the smoking of 'black' (i.e. hard dried) herrings.[2]

In red herrings, which became the standard product, although no doubt with local variations, heavy salting is combined with hard smoking. The Statute of Herrings in 1357 endeavoured to fix the maximum wholesale price and profit margins for the sale of red herrings at Great Yarmouth. The price of herrings to be cured as 'reds' was not to be above 40*s.* per last.† The fish were to be sold within forty days for a maximum of half a mark of gain and the people of London were not to sell them for more than one mark extra. Two lasts of 'shotten' (spent) red herrings were to be sold one mark dearer than a last of full red herrings 'because the curage of the last of shotten herrings draweth to as much as the last of full herrings.' In 1393 three barrels (each containing 600 to 1,000 fish depending on size) of 'white' herrings and four 'cades' (a 'cade' was 600) of 'reds' were exported side by side from London to the Duke of

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* Occasionally 'white' herrings must be taken to mean fresh herrings, not salt pickled herrings.

† This works out at about twenty for a penny. On the other hand, fresh herrings in London about 1300 sometimes cost as much as a shilling each, worth a pound or more to-day.

Brittany. In partial absolution for the murder of a dignitary of the Cinque Ports, the burgesses of Great Yarmouth in 1362 made an annual grant of 'one last of red herrings, dried and well cleaned' to the free Chapel of St. George at Windsor. In 1444 at Norwich, an effigy of Lent was clad in white and red herring skins. Cardinal Wolsey in 1525 on Maundy Thursday, gave fifty poor people a cask of red herrings along with three ells of good canvas for shirts, amongst other useful gifts.

Thomas Nashe, author of the immortal *Summer's Last Will and Testament* ('Spring, the sweet spring', etc.) and one of the more ebullient Elizabethans (*see* p. 36) was born at Lowestoft. In 1599 he published a curious 'bread and butter' work entitled '*Lenten Stuffe*; containing the description and first procreation and increase of the towne of Great Yarmouth, in Norffolke; with a new play never played before of the *Praise of the Red-Herring*.'[3] He dilates upon 'the puissant red herring, the golden Hesperides red herring, the Meonian red herring, the red herring of Red Herrings . . . St. Denis for France, St. Iames for Spaine, St. Patrike for Ireland, St. George for England and the red herring for Yarmouth . . . A red herring is wholesome on a frosty morning: it is most precious merchandise because it can be carried through all Europe. No where are they so well cured as at Yarmouth. The poorer sort make it three parts of their sustenance . . . A red herring drawn on the ground will lead hounds a false scent.' A graphic description of the latter trick was given many years later by William Cobbett who played it as an 8-year-old, about the time when, as he says, a red herring cost a halfpenny.[4]

According to Nashe, however, 'reds' did not keep as well as salt herrings. He patriotically compares East Anglian herring with 'the fat restive Scottish herrings, which will endure no salt, and in one month (bestow what cost on them you will) wax rammish [rancid?] if they be kept, whereas our embarreled white herrings, flourishing with the stately brand of Yarmouth upon them last in long voyage better than the red herring.'

Although Yarmouth and Lowestoft excelled in the 'redding' of herrings, other places made them too. The Archbishop of Bordeaux once laid in a stock of 1,000 of them from Cornwall in exchange for his wines. They figure in the Scots King's stores at Berwick in 1299–1300 and they were being made in Scotland in

1423 when James I imposed an export duty of 4*d.* per thousand on them, and 4*s.* per last on home-produced and 6*s.* per last on foreign caught salt herrings. They were shipped to the Mediterranean for Lent. Although common, 'reds' were not universally appreciated. Thus, Alexander Montgomerie complains, in 1576,

> This is no life that I leid up a land
> On raw reid herring reisted in the reik.

The red herring occasionally figured along with salt herrings in the budget of the rich, e.g. in the Household Books of James V (1513–42),[5] whilst in 1613, Yarmouth sent ten casks of full red herring 'of one night's death' for the use of the King's Household. However, 'reds' along with salt herrings, were characteristically the cheap mass-produced food of the age, and one in which Britain was pre-eminent. Thus, in 1638, the Spaniards are reported to have concluded that there was 'no clothing comparable to the English bays, nor pheasant excelling a seasonable English red herring.'[6] Two reasons given (in 1670) for the Dutch not capturing our trade in 'reds' as they had that of salted herrings, were that the fish must be brought fresh to the land to be cured as at Yarmouth, which the Dutch could not do; and they must be smoked with wood, whereas Holland was not a woody country.[7] Nevertheless, herrings caught by the Dutch off the coast at Yarmouth on the last night or two of the season were not 'gipped', but were salted slightly for making into 'reds' when they got back to Holland. In addition, the Dutch operated quite a considerable industry for smoking herring, although it was quite separate from their Grand Fishery.[8] For this they used chiefly their flat-bottomed *pinken* or *bomschuiten* (bum boats). Herrings caught by these vessels off Yarmouth were strewn with salt (or *steuren*, hence *steurharing*) on board and carried home in baskets (or *korven*, hence *korfharing*) to be smoked in the coast villages and sold as *bokking* mostly for home consumption. Similarly herrings caught in the Zuider Zee, which were small and often lean (*yele haring*) were not salt cured, but were either sold fresh, as 'pan herring', or more often smoked. These *bokking*, which never fetched anything like the price of cured herring, appear to have been either cold smoked, like reds, or else smoked and cooked in a fashion similar to the process used for the German *Bückling*. A writer in 1669 describes how corved herrings 'taken about Yarmouth were used for "redding".' He says that these fish must 'be taken on shore two or three days after they be taken, otherwise they must be pickled . . . For the making of the pickle, the observation is that it must be so strong as that a herring will swim in it, and then it doth so pine and overcome the nature of the herring, that it makes it stiffe and preserves it, otherwise if the pickle be weaker than the nature of the herring it will overcome the strength of the pickle, and so the herring will decay.'[7] This is a fairly good account, for the age, of the osmotic changes occurring during the salting of fish. Much of the same type of metaphor can still be heard in the fishing industry.

Statistics of production were lacking before the birth of 'political arithmetic' in the seventeenth and eighteenth centuries. Many of the figures recorded are often speculation and hearsay. Thus, while Camden (1570–1600) writes of Yarmouth[9] 'that it is almost incredible what a great and thronged fair here is at Michaelmas, and what quantities of herring and other fish are vended,' Nashe talks of 'the great plenty of salted fish there, not so little two years past as four hundred thousand.'[3] If this is correct it amounts to less than 100 tons. The seventeenth century civil troubles interfered with the red herring trade. In 1635 a Mr. Davis was granted a patent for gauging red herrings at Yarmouth and affixing a seal as a sign of quality. One of the last things that Charles I did before the outbreak of the Civil War was to revoke such a licence at York in 1639.

Daniel Defoe, writing in 1724,[10] reports of Yarmouth that he has 'heard the merchants themselves say (viz.) That they have cur'd, that is to say, Hang'd and dry'd in the smoak 40,000 barrels of merchantable red herrings in one season', each barrel containing about a thousand herrings (i.e. a total of about 7,000 tons). In 1755, the combined Yarmouth and Lowestoft cure was 70,000 barrels (about 12,000 tons) of which Yarmouth's share was two-thirds. They were exported as follows: Leghorn, 13,000; Naples, 7,500; Venice, 5,700; Genoa, 5,500; Ancona, 4,500: Cadiz, 900; Trieste, 700; Civitavecchia, 700; Bordeaux, 500; Holland, 13,000. The remaining 18,000 barrels were home consumed. Between 1771 and 1781 the annual home consumption of red herrings was still about the same, 13 million, whilst that of 'white' herrings, was reported to be about 4 million.[2] This only amounts to two or three per head.

By the middle of the eighteenth century, Scotland and the Isle of Man were threatening to outbid Yarmouth in the making of red and black herrings. Already in 1724 Defoe says of Dunbar that 'They have here a great Herring-Fishery, and particularly they bring herrings here, as they do at Yarmouth in Norfolk, for the smoking them: . . . I cannot say they are cur'd so well as at Yarmouth, that is to say, not for keeping and sending on long voyages, as to Venice and Leghorn, though with a quick passage, they might hold it there too . . . The Herrings also themselves may a little make the Difference, because they are generally larger and fatter than those at Yarmouth, which makes it more difficult to cure them, so as to keep in a hot country and on a long voyage.'[11] In 1777 a company at Dunbar and another at Eyemouth had smoke houses large enough to cure at one time nearly a hundred lasts, but the venture seems to have collapsed because the fish were unsuitable for smoking, probably owing to their being too fatty.

The number of barrels of red herring prepared at Yarmouth both for domestic consumption and export fell from 51,855 in 1739 to 18,802 in 1782. Between the years 1788 and 1797, 129,635 barrels were exported from England of which the 'Streights and Gibralter' and the West Indies took the majority, negligible quantities going to Russia, Prussia and Germany.

However, on the whole, the output and market for British 'reds' during the last century seem to have been relatively stable, compared with those for salt herrings, for example. In 1853, about 10,000 lasts (20,000 tons) were produced, and in 1913 the figure was not much different, although by then constituting only 6 per cent of the total catch.

By comparison, the Dutch trade in *bokking* expanded considerably during the nineteenth century.[8] In 1823, thirty-five ships were engaging in the fishing and the catch was only 4 million herrings (less than 1,000 tons). In 1853, 118 ships caught 23½ million fish (about 4,500 tons), and in 1881, 55 millions (about 10,000 tons) were caught, still mostly by bum boats, of which quantity however, 75 per cent were now exported. Some of these were 'reds', but in addition there was until recently a considerable export far into Germany of hot smoked herring named after the town in which they were produced, e.g. *Harderwijkers*, *Monnikendammers* on the Zuider Zee.[12]

The methods used for smoking herrings to produce reds have changed very little. A description of procedure at Lowestoft and Yarmouth in 1874[13] can be taken as representing the process used throughout the preceding centuries. The herrings were first washed to get rid of the salt put on them aboard ship as soon as they were caught, and were thereupon put into salt again for fourteen days. The fish were then taken out, washed, 'rived', or 'speated' on 'spits' or sticks through gills and mouth, twenty-five fish to a stick, and smoked for a further fourteen days.

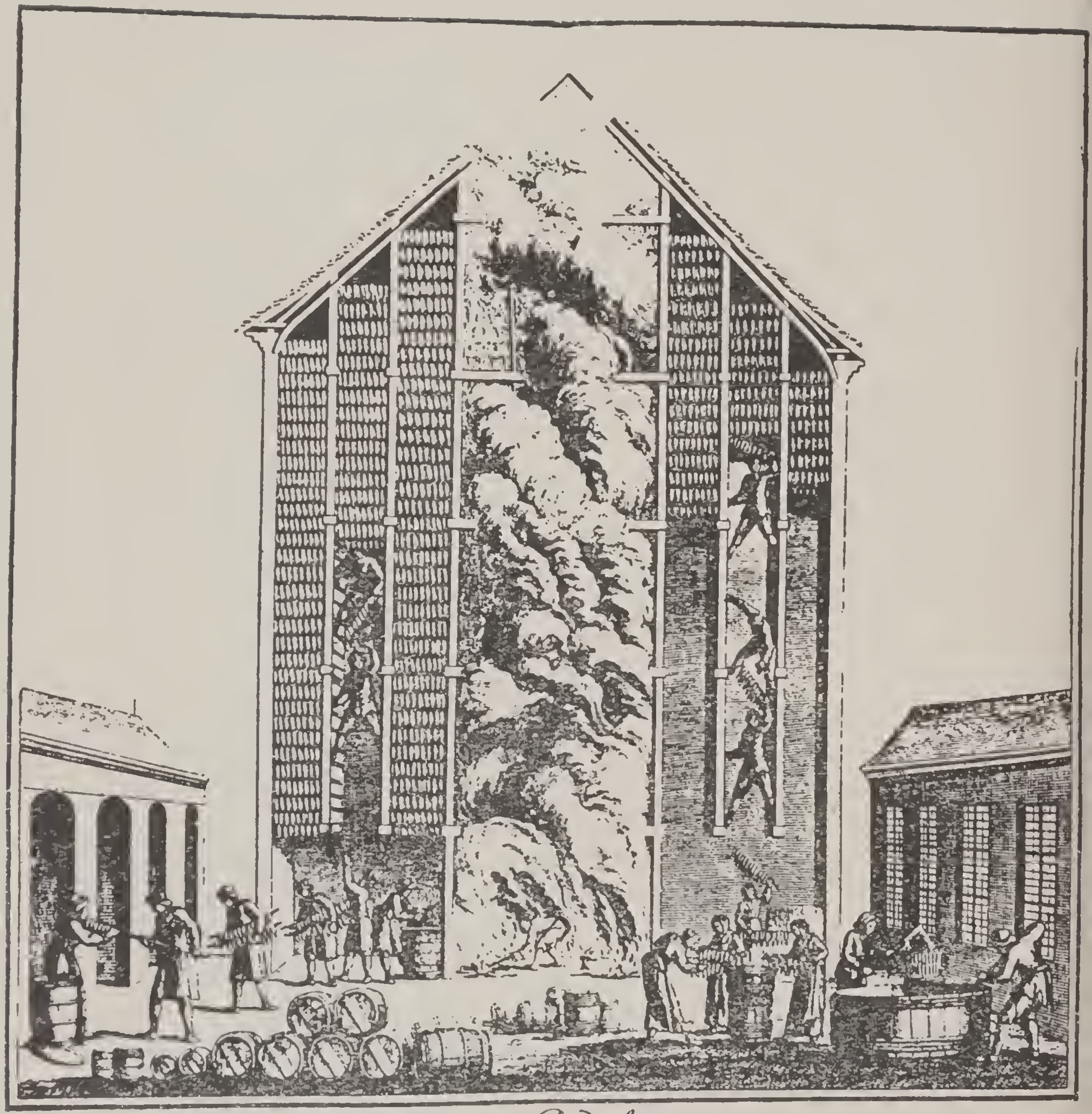
The smoke house consisted of a lofty room about sixteen feet square, with a series of wooden frames reaching from floor to roof, with small transverse beams, called 'loves', running from one side of the room to the other. These frames were about four feet apart, and the spits were placed in rows one above the other between them, the ends of the spits resting on the 'loves'. The roof was covered with tiles, which were not cemented, so as to allow a good draught through the room, which when filled held three lasts, i.e. about six tons or over thirty crans of fish. On the stone floor of this smoke house about sixteen fires were laid, consisting of oak billets, which were regarded as giving the best colour, although ash was used too. The fires were lit and kept burning for two days, after which they were allowed to go out and the fish allowed to drain and drip for a day. Then the fires were again lighted for two more days and so on for fourteen days, at the end of which the fish were regarded as being thoroughly cured, or 'high dried', and fit for packing in barrels. When filled, a screw press was brought to bear on the fish, which were tightly flattened down so as to allow an additional number to be stowed away. Usually about 650 full-sized fish were packed into a barrel, or more if the fish were smaller. Until well towards the end of the last century fast clipper schooners were still employed to take Yarmouth 'reds' to Greece and Italy.

BLOATERS

The 'bloater' was a less famous herring product. It was like a red herring, but not so smoky, although much saltier than the 'Yarmouth bloater' of to-day (*see* p. 276). The name is apparently derived from a Swedish word *blöta*, implying 'soaking', or 'steeping', i.e. presumably in brine prior to smoking, although Icelandic *blautrfiskr* means soft (i.e. fresh) fish (cf. *hardrfiskr* for dried or stockfish) and is connected with 'bloated' meaning swollen. The product must have been popular in Elizabethan times from the references of dramatists. Beaumont and Fletcher's *Island Princess* contains the line (II, 5): 'I have more smoke in my mouth than would blote a hundred herrings'; and in Ben Jonson's *Masque of Augures*, seventeenth speech, we read, 'Why you stinke like so many bloat herrings newly taken out of the chimney', both contemporary references to the recent introduction of tobacco.[2] They were first exported from Yarmouth to Spain and Italy about 1600.

PRESENT-DAY PRACTICE

In current practice, ungutted herrings to be made into 'reds' are 'roused' with dry salt in vats for about a week. Fluid is extracted from the fish and its salt content reaches about 15 per cent. At this stage they have absorbed sufficient salt and they are taken out of the vats, washed and smoked. Very often the fish are kept under brine for longer periods. Ultimately, the flesh becomes permeated with a saturated salt solution if sufficient solid salt is present; in this state they are often kept covered with pickle for several months. Such 'vatted' fish have to be desalted by soaking in water prior to smoking, otherwise the drying would result in salt crystallizing in the form of a white powder on the outside of the fish. Overnight soaking reduces the salt content to about 10 per cent. The fish are then hung upon rods in kilns, which have evolved very little since the Middle Ages (*see* Fig 5), and smoked in cool smoke for about a week, losing about 20 per cent by weight as a result of evaporation. Too rapid drying results in 'case-hardening' in which the outer layer becomes excessively dry whilst the inside still remains moist. Usually the fish are still given intermittent periods of smoking with periods of rest to allow moisture to diffuse



Making Red-herrings

By courtesy of John Murray (Publishers) Ltd.

FIG. 5.—Making Red-herrings. *From* The Herring *by A. M. Samuel.*

through the outer layer to the surface. This Mediterranean cure is golden in colour compared with the hard, shrivelled darker-brown product mostly produced in earlier times, which was smoked for up to six weeks.

'Silver cured' herring are a form of mildly smoked, old-fashioned bloater, which have a more restricted market than 'reds'. They are salted for a somewhat longer period than 'reds', or not desalted as much in the case of vatted fish but are smoked usually only for one night, so that they take on very little colour.

The chemical composition of both 'silvers' and 'reds', is approximately 40 to 45 per cent of water, 15 per cent of salt and 15 to 20 per cent of fat. Fish that are too fatty do not make good 'reds'. The East Anglian autumn herring, which usually contain between 10 and 15 per cent of oil, are ideal, but the north-east Scottish fish at the beginning of the season, when they contain 20 per cent or more, are generally speaking too oily.

The British ouptut of 'reds' in recent years has been of the order of 10,000 tons per annum, almost all of which is exported. The Netherlands, Norway and France also enter into the export market. They are not now much eaten at home except in small quantities in so-called 'bloater pastes' and in *hors d'œuvres*. Possibly a milder, less salty cure would find greater favour in the home and perhaps also the export market, although if sale were not to be quick, cold storage would be advisable to prevent spoilage.

PILCHARDS

Pilchards, which are a surface-shoaling, seasonal, fatty fish related to the herring, occur mostly farther south than herrings, e.g. in the Mediterranean, although they overlap and are occasionally taken together in East Anglia.

Pilchards caught off Cornwall and Ireland were salt cured and barrelled like herrings from the Middle Ages onwards. Being on the whole a fattier fish even than herring, they were pressed in the barrels to remove some of the oil, before 'topping up' with brine and lidding. In this form they were esteemed as a delicacy not only in England but also in the Mediterranean countries, where they were known as *fumadoes* (corrupted to 'fair maids') which, as the name suggests, also seem to have been smoked. Camden's account says that the Cornish 'make likewise a gainful trade of those little fishes they call Pylchards, which are seen upon the sea coast, as it were in great swarms, from July to November; these they catch, garbage [i.e. gut and clean], salt, smoak, barrel, press and so send them in great numbers to France, Spain and Italy, where they are a welcome commodity and are named fumadoes.' He quotes Latin verse with quite a prophetic combination:

Piscibus et stanno nusquam tam fertilis ora

translated as:

In fish and tin they know no rival shore.

About 6,000 hogsheads of pilchards were exported every year, from Plymouth etc., chiefly to Italy, in Elizabethan times.

It seems as though it was a technical revolution in the catching of pilchards in the reign of Elizabeth which had the effect of changing over the method of preservation from smoking to salting. Seine-netting was then becoming prevalent. This method of fishing required three or four boats per net, each carrying six men apiece. This tended to the elimination of the smaller men and led to the domination of the market by the merchants, dealing on a larger scale, chiefly for the export market. According to A. L. Rowse, an authority on Tudor Cornwall, 'the needs of the export market brought about a change in the manner of curing the fish: instead of being smoked singly, they were finned and packed into hogsheads "made purposely leaky, which afterwards they press with great weights, to the end the train [oil] may soak from them into a vessel placed in the ground to receive it"', as described by Richard Carew in 1602[14] (*see also* page v). At Plymouth, there was a conflict of interests between the townsfolk, whose mayor in 1581 was none other than Sir Francis Drake, and the merchants who set up their cellars, or 'palaces' as they are still called in Cornwall, for storing fish, at Cawsand, at the mouth of the bay. The merchants forced up the price of fish. Carew complains that 'this commodity at first carried a very low price, and served for the inhabitants' cheapest provision; but of late times, the dear sale beyond the seas hath so increased' exports that only 5 per cent were then home consumed. 'The pilchard merchant may reap a speedy, large and assured benefit, by dispatching the buying, saving [i.e. curing], and selling to the transporters, within little more than three months' space. Howbeit, divers of them [gambling on futures] cut their fingers.'

There were protests against this export, as for example a petition of 1578, which begins 'whereas divers kinds of sea fishes, as congers, hakes, pilchards, skates, rays, thornebags [thornback rays], papillions [butterfly rays] and dogs [dogfish] being necessary victuals for the people of this realm . . . now of late altered from their kinds by curing without salt or otherwise converting them into gross oils, for the contentation of foreign realms and to the great increase of dearth and lack and penury of this realm and in especial in the west parts of Devon and Cornwall, etc.'

The Corporation in 1588 forbade the dressing of pilchards by finning them 'a matter of late years used to make them meet to be carried out of the realm', and in addition no pilchards were to be converted into train, as a measure 'to increase the said fish observed for meat.' However, the new method of curing was less laborious and, despite restrictions, it captured the field.

Defoe, in 1724, commented that in the pilchard fishing, Dartmouth had the 'greatest number of vessels of any part in the west except Falmouth'.

Ireland, too, had a prolific pilchard fishing throughout the seventeenth century.[15] The fish were brought into a shed where they were laid on a sloping stone platform between alternate layers of salt, and remained there for fifteen to twenty-one days, until all the oil, blood, brine, etc. had ceased to run off. They were then washed, carefully drained and pressed into barrels. Each barrel was stood on a false bottom, just a little less in diameter than the bottom of the cask. A circular, wooden 'buckler', or false head, used as a kind of piston, was then placed on top of the loosely packed fish and by means of a long press beam the false head was pushed into the barrel. More pilchards were added and the process repeated until it was impossible to add more fish, when the barrel was headed up for export. The oil draining out of the barrel, which had a series of holes in the bottom, was a valuable by-product of the curing process. When roughly purified it was marketed as train oil for tanning leather, as an illuminant and for other purposes.

At Baltimore, Co. Cork, one of the most important centres, the remains of the holes for supporting the press beams are still to be seen in the rocks: and nearby, thick deposits of pilchard scales (which are much harder and more conspicuous than those on a herring) were found when new roads were being built recently.

Even in 1872 no Cornish household was without its own stock of pilchards for the winter. The fishing, still seine-netting, although variable, resulted in an annual cure of up to 4,500 hogsheads. A description of the process at the time although affording more details shows that it was quite unaltered.[13] The pilchards were packed in alternate layers of coarse salt and fish on the stone floor of the curing house until the bulk was five to six feet high. Here the fish remained for a month and the oil and brine draining away was carried off by gutters in the floor to a cistern. The fish were then washed and packed in hogsheads with head outwards and a rosette of fish in the centre. The 'buckler' was placed on top of the fish and a strong but gradual pressure applied by means of a lever until the mass of fish was reduced by about a third of its bulk. The considerable quantity of oil which was squeezed out, drained through the sides and bottom of the cask, and was collected as before. The cask was filled three times before pressing was finished, which occupied in all eight or nine days. The weight of the hogshead was then about 4 cwt. gross. The quantity of oil obtained depended on the season, but was at least two gallons per hogshead. Fish caught early in the season produced most oil. There were about 2,500 fish in a hogshead on the average. About 5,500 hogsheads were exported every year to the Mediterranean and Italian ports at that time.

Immature fish of the same species, caught in the Mediterranean and off Brittany as 'sardines' were also preserved by salting and other means (*see* p. 194). Sprats, which are a distinct pelagic species, smaller than herring and pilchards, but of the same family and characteristics, were preserved in a similar manner. Thus, Defoe says of Dunwich and 'Swole' (Southwold) in Suffolk that 'they cure sprats in the same manner as they do herrings at Yarmouth; . . . they make red sprats; or to speak good English, they make sprats red.'[19]

SALMON

Although salmon is not in the same class as herring, pilchard, etc., it is more similar to them than to white fish on account of its high and seasonally fluctuating fat content. For this reason it has usually been preserved, like herring, by salt pickling in barrels topped up with brine, or by smoking.

Pickled salmon was early on an important item of trade, particularly in the north of England and Scotland, where it was a source of wealth to many monasteries. As early as 1273, Aberdeen merchants were exporting salmon to England and the Continent.[16]

The father of the famous Bishop William Elphinstone of Aberdeen (who died in 1515) was a big figure in the exportation of the Aberdeen salmon, chiefly to Flemish and Dutch ports, in the second quarter of the fifteenth century. When the Navigation Act in 1671 banned the importation of foreign salt, there was a petition against it from Aberdeen merchants on the grounds that home-produced salt was not suitable for their salmon. In the seventeenth century the rivers Dee and Don produced, in favourable seasons, over 1,400 barrels of 250 lb. each, i.e. a total of about 170 tons. The magistrates of the town supervised the manufacture of barrels of the correct size, the salting and packing of the fish and the branding of the barrels with the letters ABD. In 1712, 1,270 barrels were exported, chiefly to Germany, Holland, Spain and Portugal, and in 1713, Venice is mentioned.

In his *Tour* of 1724, Defoe was particularly impressed with the amount of salmon curing he saw in the north of Scotland. Of Perth he says 'the salmon taken here and all over the Tay is extraordinarily good and the quantity prodigious. They carry it to Edinburgh and to all the towns where they have no salmon and they barrel up a great quantity for exportation.'

At Aberdeen 'The salmon is a surprising thing, the quantity that is taken in both rivers, but especially in the Dee is a kind of prodigy . . . and they are sent abroad into several parts of the world, particularly France, England and the Baltic.' In Caithness and the north of Scotland generally there were 'Salmon in such plenty as is scarce credible and so cheap that, to those who have any substance to buy with, it is not worth their while to catch it themselves. This they eat fresh in the season and for other times they cure it by drying it in the sun, by which they preserve it all the year.' On the other hand at Annan and Kirkcudbright in the south-west, which had at one time possessed good salmon fisheries, Defoe was disappointed that they were not in his time more extensive. 'Salmon come and offer themselves, and go again and cannot obtain the privilege of being made useful to mankind, for they take very few of them . . . They have also white fish, but cure none, and herrings, but pickle none.'[11]

In 1757 and again in 1761 there were complaints from Campvere, the Scottish Staple in the Netherlands, regarding some badly packed and cured salmon. In the latter case they were branded ABDN and were subsequently traced to a John Burnett, lessee of the Ythan salmon fishing. This led the magistrates to tighten up the regulations and publish their brand marks abroad.

'Powdered' salmon was eaten in London in the fifteenth and sixteenth centuries, although it was by no means a common food.[17] Like powdered meat, it was preserved by dusting with crushed salt, although since powdering became a general term for preserving by pickling or spicing, it is possible that this product was just the ordinary salt-pickled salmon.

Smoked salmon was hard and salty, like red herrings, and in no way similar to the present-day mild-cured product.

'Kippered' salmon was mentioned in the Household Book of James V of Scotland[5] (died 1542). In 1479, it is reported in the records of the monastery of Cupar, in Fife, that the salmon fishery at Campsie was obliged to deliver three dozen fish yearly, fresh or kippered.[18] A 'kipper' is a salmon which has spawned (*kuppen*, in Dutch, means 'to spawn') and lurks about, out of condition, in deep pools.

In England in 1376, the Commons petitioned the King that no salmon should be allowed to be caught in the Thames between Gravesend and Henley in the 'Kipper Time', viz. between the feasts of the Invention of the Cross (3rd May) and Epiphany (6th January).[16]

Izaak Walton used the word as an adjective in his version of the story as follows:

'The Salmons having spent their appointed time, and done this natural duty in the fresh waters, they then haste to the sea before winter, both the melter male and spawner female; but if they be stopped by flood-gates or weirs, or lost in the fresh waters, then those left behind grow sick and lean, and unseasonable, and kipper, have bony gristles grow out of their lower chaps, not unlike a hawk's beak, which hinders their feeding; and, in time, such fish so left behind pine away and die. 'Tis observed, that he may live one year thus from the sea; but he then grows insipid and tasteless, and loses both his blood and strength, and pines and dies the second year . . . The He-salmon is usually bigger . . . more kipper, and less able to endure a winter in the fresh water than she is; yet she is, at the time of looking less kipper and better, as watery and as bad meat.'[20]

Walton, who was prepared to believe in the spontaneous generation of pike and other fishes out of mud, is not above reproach as a natural historian. In fact, the gristly process on the lower jaw of the male develops during the growth of the milt. As a result of starvation the fat content of the fish post-mating is very low. Poor colour and other changes perhaps associated with the reproductive process, make the flesh generally disagreeable, and to the true salmon fisherman, rather repulsive.

When caught, the lack of fat and emaciated appearance of a kipper led to its being split and smoked to make it more palatable. It may have been, too, that on account of the low fat content there was less trouble with rancidity in a drying, as opposed to pickling process. In fact, kippered salmon did not always necessarily mean smoked salmon. In a recipe for kippering in 1882,[21] the salmon was first split right down the underside of the dorsal fin, including the head, and then salted, sometimes with the addition of saltpetre, rum or sugar, and finally dried in the open with occasional stacking for four or five weeks in a similar fashion to the drying of salted cod. It was when the drying was expedited by means of a kiln in which artificial heat was provided by the combustion of wood that the fish, of course, took on a smoky flavour. Not until the middle of the nineteenth century was the word kipper first used in connexion with smoked herring.

'Newcastle salmon', highly esteemed in London, actually came from the Tweed, as Defoe discovered to his disappointment.[10] It was taken by horse to Shields and either salted and dried, or boiled and pickled in vinegar and then sent to London by ship.

Mrs. Gardiner's Receipts from 1763, published at Boston, Mass., gives a recipe 'To Pickle Salmon the Newcastle Way, according to a Receipt procured from England, as is said by the infamous Governor Sir Francis Bernard.'[22] After scaling, splitting down the back and removing the backbone and washing, it is cut into 'Junks of about four or five inches thick. Put on your Pot of Water, making it sharp with salt, and when it boils put in your Junks of Salmon, and let them boil for twenty-three Minutes. Then take it off the Fire and let it cool. Make a Pickle with two ounces of Allspice, two ounces of black Pepper and one Gallon of Vinegar, which boil, and into which, when cold, put a handfull of Salt. Place the Salmon in a Keg, and, when the Salt is dissolved, pour the Pickle upon the Salmon. After it has stood one night in this manner, strain off the Oyl that may have arisen on the Top, to prevent its acquiring a strong taste and then head up the Keg.'

After the Union of 1707, Aberdeen salmon, too, when treated in this way, found a ready market in London. It was exported in swift sailing smacks since it was more perishable than the hard salted cure still sent to the Continent, and needed relatively quick distribution.

The Dutch method of about 1800 of preserving salmon with smoke after parcooking, is said to have been the forerunner of the sardine process.[21] 'As soon as the fish is caught, they cut off the end of the snout [i.e. behead] and hang it up by the tail to let the blood flow out as much as possible. A short time after, they open its belly and empty it and wash it carefully. Then they boil it whole in a brine of white salt, often skimmed. Before it is quite boiled [i.e. cooked], they take it out of the brine and are careful not to injure the skin after which they let it cook and drip on a hurtle. Then they expose it for a day or two to the smoke of a fire of juniper, which must make no flame. Finally, they put it into a tin box, the sides of which must be one inch higher than the thickness of the fish, and fill up the box with fresh butter salted and melted. When the butter is coagulated, they put on the cover and solder it to the lower part of the box. Some persons eat the fish without boiling it again, but it is better when it gets a second boiling. In winter, good oil of olives may be used instead of butter.' Juniper wood is still used to confer a delicate flavour on smoked salmon.

Char, a related fresh-water species from the Lake District was 'potted' in a somewhat similar manner. Defoe in 1724, mentions 'Winander Meer . . . which is famous for its char fish . . . [which] as a dainty, is potted, and sent far and near, as presents to the best friends; but the quantity they take also is not great.' It was still on sale in London when Hofland's *British Angler's Manual* was published in 1848. It was perhaps this dish, too, that Arthur Young in 1771 reports as potted trout with which he was served for tea at Penrith, in Cumberland for 1*s.* 9*d.*

In one of the recipes for this product, the fish, after cleaning and scaling, was cooked slowly in white wine with a little onion, carrot and parsley, cooled, skinned, filleted, all the bones removed and arranged in an earthenware 'pot'; covered with melted butter and heated in an oven for about half an hour. The product had a fair keeping quality if kept cool.

Shrimps are preserved by cooking and covering with melted butter to this day. Presumably the layer of fat delays airborne bacterial infection and possibly makes it more difficult for atmospheric oxygen to attack the fat of the fish and turn it rancid.

At the turn of the eighteenth century the rivers of north-east Scotland must have been exploited more intensively, since even allowing for the variation between one season and another the production appears to have increased. In 1798, a good season, the Dee produced 1,890¼ 4 cwt. barrels, and the Don 1,667 barrels, a total of about 700 tons; whilst even in 1804, which was a poor season, the respective outputs were 652½ and 349, or about 200 tons. The average was about 1,100 barrels from the Dee and 900 from the Don. Two other Aberdeenshire rivers, the Ugie and Ythan, together produced between 200 and 600 barrels a year. 'Not above one pound of salmon is consumed in the country to 40 that are exported', said a contemporary writer,[23] London being the chief market. Pickled salmon was apparently still a common article in London at the time of *Pickwick* (published 1836–37), and, bracketed with oysters, is associated by the Wellers, father and son, with mean streets and poverty. In 1849, just before railways opened up the north of

Scotland, a writer on Scottish fisheries commented that although the pickling of salmon was not then so much resorted to, the product was still considered quite a delicacy during Lent. The description he gives is obviously more suitable for large-scale production than Mrs. Gardiner's more domestic 'receipt'. 'The water being at the boiling point, salmon are allowed to boil for half an hour, and grilses twenty minutes. The fish is then allowed to lie and cool for a night, when it is then packed in kits. These are filled up with strong vinegar, with about a gallon to each kit' which contains about 25 lb. of fish.[24]

Salmon was, of course, a valuable fish on which it was possible to lavish costly attention. Defoe noted that it was carried to London in the 'fresh' condition by land-carriage not only from places such as Chichester but also from as far away as Workington on the Derwent in Cumberland, 'so that the fish come very sweet and good to London', but this devotion made it, not unnaturally, very expensive 'being often sold at two shillings and six pence to four shillings per pound', an enormous price in those days.[10] In the words of Charles Kingsley, salmon was 'of all Heaven's gifts of food, the one to be most carefully protected.' It was, in fact, the first fish on which ice was systematically used for preservation in this country at the end of the eighteenth century (*see* p. 214). However, it was the coming of the railway in the mid-nineteenth century which ensured the prompt transport of salmon to London from the North, and after that, pickling of salmon 'in the Newcastle way' became obsolete as a means of preservation and soon died out. The effects of increased exploitation began to appear when the catches showed signs of falling off by the middle of last century. Thus the number of cwt. boxes of iced salmon sent from Scotland to London fell from 30,650 in 1834 to 15,823 in 1859, the best year being 1835 with 42,350 boxes. The price varied between 7⅛*d.* and 1*s.* 0⅞*d.* per lb.

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Chapter 5

THE RISE OF THE BRITISH HERRING FISHERY

Successive British governments from Elizabethan times onwards through the seventeenth and eighteenth centuries, cast envious eyes on the success of the Dutch and made various efforts to encourage the fisheries for both 'whyte and gray fishes', i.e., chiefly, cod and herrings. Yarmouth, Scarborough, and Bridlington were the only towns of importance engaged in the herring fishery at the beginning of this period.

Camden, in his account of Scarborough,[1] complains that 'Those of Holland and Zealand carry on a very plentiful and gainful trade of fishing in the Sea here for herrings, whereas by an old Constitution they use to get a licence first from this castle. For the English always granted leave for fishing, reserving the Honour to themselves, but out of a lazy temper resigning the gain to others. For 'tis almost incredible what vast gains the Hollanders make by this Fishery on our coast. These herrings . . . which in the former age swarmed only about Norway, now in our time . . . swim in great shoals towards our coasts. About Mid Summer, they draw from the main sea towards the coasts of Scotland, at which time they are immediately sold off, as being then at their best. From thence they next arrive on our coasts; and from the middle of August to November, there is excellent and most plentiful fishing for them all along from Scarborough to the Thames mouth. Afterwards by stormy weather they are carried into the British Sea and there caught till Christmas, thence having ranged the coast of Ireland on both sides and gone round Britain they convey themselves into the Northern Ocean, where they remain until June; and after they have cast their spawn return again in great shoals.' Biologists to-day, of course, find the picture of the annual migrations of herrings considerably more complicated than this one of perpetual circumnavigation of our isles.

Sir Walter Raleigh (*see* p. 68) and 'Tobias Gentleman' (*see* p. 66) wrote on the same theme a few years later.

Better methods of curing and better sales organization enabled the Dutch to control the foreign market and even to sell their produce in this country. It was complained in 1623 that the Dutch 'to the ignominy and shame of our nation do vend our herring amongst us here in England, and make us pay for the fish taken upon our own coast ready money.'[2] One half of the fish sent to London was supplied by their vessels.

As early as the fifteenth century, the Dutch 'busses' far outnumbered and outfished British ships. In comparison with the Dutch busses, the 'cobles' or 'fivemen' of the Yorkshire and Durham coast were only small, light open boats, ill able to keep at sea in heavy weather and capable of carrying at most only three lasts of herring. Theirs were 'great and strong and able to brook foul weather [whereas] our cobles, crayers and boats being small and thin sided [were] easily swallowed by rough seas.' Yarmouth in 1344 had about 220 fishing vessels and even in 1597 still had only 250 vessels fishing for herrings. In 1600 the Dutch had 5,000 fishing vessels of various sorts, of which 1,600 were employed in British waters. In the middle of the seventeenth century the Dutch herring fleet numbered about 2,000 busses of 50 to 120 tons. A number of armed vessels convoyed this fleet. Robert Hitchcock, about 1600, put forward a scheme for a fleet of 400 ships of 70 tons each, which were to produce 5,000 lasts of pickled herrings for London's consumption and 5,000 more for the rest of the country, employing 10,000 men. Nothing came of this particular scheme which was one of the first of numerous attempts made to institute in Britain a herring-curing industry on the same lines as the Dutch. Thus in 1612, Aberdeen magistrates purchased a completely equipped fishing vessel in Holland and engaged a Dutch skipper to train the Aberdonians in the art of catching and curing fish. Nothing more was heard of the scheme and the Dutch still retained the monopoly, their fleets of busses working within sight of the shore.[3] A century later, in 1712, Aberdeen exported 90,000 stockfish to Italy and an even greater amount of salt cod and ling to Italy, Spain, Portugal, Norway, and Sweden; but only 200 barrels of herrings were mentioned.

In 1632, the Society of the Fishery of Great Britain and Ireland, of which the Lord Chancellor was a shareholder, erected houses for curing and packing herring on the Island of Lewis in the Outer Hebrides, but 'the herrings failed to come' and the scheme collapsed. There was a more determined, government-subsidized attempt to rival the Dutch methods in 1641 (*see* Plate 2). The nets were shot in the evening 'and in the morning they get them in again and gip [gut], salt and pack all the herrings.'[4] When the fish were on board, one man took the herrings out of the well with the 'ladnet' and filled the gippers' baskets. Nine gippers cut the herrings' throats and took out the guts, and flung the full herring into one basket and the shotten into another. One man took the full baskets of gutted herring and carried them to the 'rower backe, wherein is salt.' A boy 'rows' them up and down in the salt while another took the rowed [our 'roused'?] herring in baskets to the packers. Four men packed the herring into barrels while another took the full barrels from the packer. The barrels stood open for a day, so that the salt could dissolve in the pickle and the fish settle down; then the barrels were filled and headed up.

The different varieties of herrings were described. 'Seasticks' were herrings as they were packed at sea. They were subsequently repacked on shore seventeen barrels making, after they had 'pined' (i.e. a word that is still used officially,[5] meaning shrunken as a result of osmotic changes), twelve barrels repacked: 'the manner is to take out the herring, washing them in their own pickle, and so lay them orderly in a fresh barrel, which have no salt put to them, but trodden down close as may be and then headed up.'

Summer herring, taken from June to 15th July, were sold as seasticks, 'to be spent presently in regard of their fatness, and will not endure repacking, and so go one with another full and shotten,' i.e. those which were full of roe and those which had just spawned. 'Crux herring' (14th September being *Exaltio Crucis*, whence also the Dutch 'Kruis' brand) were made 'with salt upon salt' (*see* p. 48) and carefully sorted out.[6]

An Act in 1675 prescribes 'How white or red herrings of English catching are to be packed, salted, dried. Baillifs of Yarmouth, etc. appointed packers.'[7]

THE DECLINE OF THE DUTCH FISHERY

There was frequent naval warfare between English and Dutch in the seventeenth century. Blake captured about 100 Dutch busses off Buchan Ness in 1652. Andrew Marvell, M.P. for Hull and Milton's assistant during the Commonwealth, imagined, in a jubilant poem celebrating one of Blake's victories (1653):

> The fish oft times the burgher dispossessed
> And sat, not as a meat, but as a guest . . .
> Whole shoal of Dutch served up for Kabillau . . .
> For pickled herring, pickled heeren changed.

That year, the Dutch herring fleet, still amounting to some 2,000 sail, was kept at home: this was its first serious check. For the next sixty years until the Peace of Utrecht in 1713, Holland was at war either with England or France or both, and in addition Dunkirk privateers took a heavy toll.

In 1702 the war of the Spanish Succession broke out and in that year four French men-of-war defeated an armed convoy and burnt 400 vessels of the Dutch fleet in Bressay Sound in the Shetland Islands. In spite of the ravages of war, the Dutch still attempted to continue the fish trade on the basis established in their supremacy. For example, all fish had to be brought to Holland before they could be sold, and fishing could not be begun before the appointed day, despite the fact that they now had competitors in the field.

The Dutch had practically monopolized the trade with Hamburg, which was one of the leading markets for salted herring, and distributed throughout middle Europe. In the early years of the seventeenth century, however, there were many complaints about the quality of their product, and a Convention was drawn up in 1609 regulating the fishery so as to keep out all herring unless certified to have been caught after 24th June and cured on board. In 1710 the British Ambassador at Hamburg, despite protests from the Dutch, obtained exception from these regulations for early Scottish herring, and by 1717 these constituted about one-sixth of the total of 3,726 lasts (over 7,000 tons) supplied to Hamburg. These fish at the very beginning of the season commanded an exceptionally high price. Not until 1752 were Dutch-cured fish for the first time allowed to be taken straight from the North Sea to Hamburg. Dutch superiority suffered a rapid decline during the eighteenth century. Whereas in 1679, after the Peace of Nijmegen, they had 4,000 vessels and 200,000 men employed in fisheries, by 1736 the herring fleet numbered only 300 sail and in 1779, 162. In 1756, however, the Dutch still had 152 vessels fishing off the coast of Ireland, while Scotland had only seventeen. In 1750, incidentally, it was estimated that 1,100 British fishermen were engaged in Dutch boats. By 1784 there were only 270 busses altogether.

After the zenith of Dutch supremacy in the middle of the seventeenth century, the quality of their product also began to fall away. Thus in 1683 Danzig merchants complained that the Dutch branded herring were frequently unsaleable or sent back to the seller from the inland German towns in consequence of the fish being bad or the barrels half-filled with salt, etc. Four years later the Dutch ambassador in Stockholm pointed out to the States that unless the former quality were retrieved, the Dutch were in danger of losing their trade in Sweden to the Scotch curers.

In 1721 and again in 1727, Stettin complained of the Dutch branded cure. By 1775, the Danes and Norwegians had captured almost the whole of the lucrative Russian trade from the Dutch.

After the Napoleonic Wars in 1815 Holland had only 137 busses, each landing an average of twenty-six lasts totalling about 7,000 tons, and the decline continued, until in 1853 there were ninety-two ships landing a total of less than 5,000 tons.[8]

THE BOUNTY SYSTEM

In 1750, under George II, the Society of the Free British Fishery was formed, to build busses and to engage persons experienced in the 'sorting, curing, gypping and barrelling of herring.' 'Danish skippers lately arrived from Holland' were engaged. They set sail for Shetland on 5th June, instructed to pack one barrel of salt to three-and-a-half barrels of herrings, and two bushels more if repacked. If time permitted they were to mark the barrels '"M" for Maties or Maiden, "F" for Full and "S" for Spawn'd.' *Matties* or *Matjes* according to one derivation is the Dutch word for 'virgin' (cf. German *Mädchen*) and refers to 3- or 4-year-old fish that have not matured. *Jagers*, or tenders, were to take the herrings from the busses to market. As a result partly of bad management and bad technique (167 barrels out of 417 taken to Hamburg on one occasion were bad), and the depredations of French privateers, the project finally collapsed in 1772 when the busses and other effects were sold at the 'Old Swan' at Southwold.[10] However, in 1755, 70,000 barrels had been cured at Yarmouth and Lowestoft, of which 52,000 were exported.

Various subsidies called 'bounties' were provided in 1705 to encourage the fishery. By an Act of 1718, 2*s.* 8*d.* was paid for every barrel of 'white' herrings exported, 1*s.* 9*d.* for full 'reds' and 1*s.* for shotten 'reds'. Officers could enter into any warehouses to inspect the curing. In 1750, 30*s.* per ton burthen was paid for decked vessels of twenty to eighty tons built for the herring fishery. Each vessel had to have on board twelve Winchester bushels of salt, carried in new barrels, for every last of fish which it was capable of holding.

The bounties were altered from time to time. In 1787 the small boat fishery of the west of Scotland was included in the bounty scheme. Before the Union of 1707, some 600 to 900 small boats and 4,000 men were employed in the Clyde between 25th July and Christmas. Some of the fish were sold locally, and some converted into 'reds'. The majority were exported, e.g. in 1674, 20,400 barrels went to Rochelle. An annual export of 3,750 tons seems to have been average.[10]

Similarly in a twelve-mile strip of the Fife coast there had been 168 boats employing 3,120 men producing 12,000 barrels a year and the Moray Firth was also important.

'Towards the end of the sixteenth century,' says one Scots writer, 'the Scotch in the exportation of herring became in some degree rivals to the Dutch.'

Defoe in his *Tour* published in 1727,[11] writing probably from personal experiences as Secretary of State Harley's secret agent in Edinburgh at the time of the Union of Parliaments, gives a picture of a flourishing herring industry in Scotland, particularly on the east coast, whence 'Herrings pickl'd and barrell'd' and 'Dry'd salmon, herrings and white fish' were exported to France and to 'Spain and the Straits' (i.e. the Mediterranean).

At Queensferry on the Firth of Forth he says he 'must take notice of a thing which was to me very surprising, I mean as to the quantity of herrings taken; and that might be taken in those seas. There was at that time a fleet of between 700 and 800 sail of Dutch Busses come into the Firth, loading with Herrings, and their convoy with them for it was in the time of the late wars; the Scots themselves had taken a vast quantity, for they said they had a very good fishing all along the coast of Fife and of Aberdeen; and the Dunbar men, and the Firth boats, were every day taking more.'

Buckhaven in Fife was 'inhabited chiefly if not only by Fishermen, whose business is mostly to catch fresh fish every day in the Firth and carry them to Leith and Edinburgh markets . . . They also have a great many boats of all sorts and sizes and some larger, which lye upon the beach . . . which every year they fit out for the herring season in which they have a great share.'

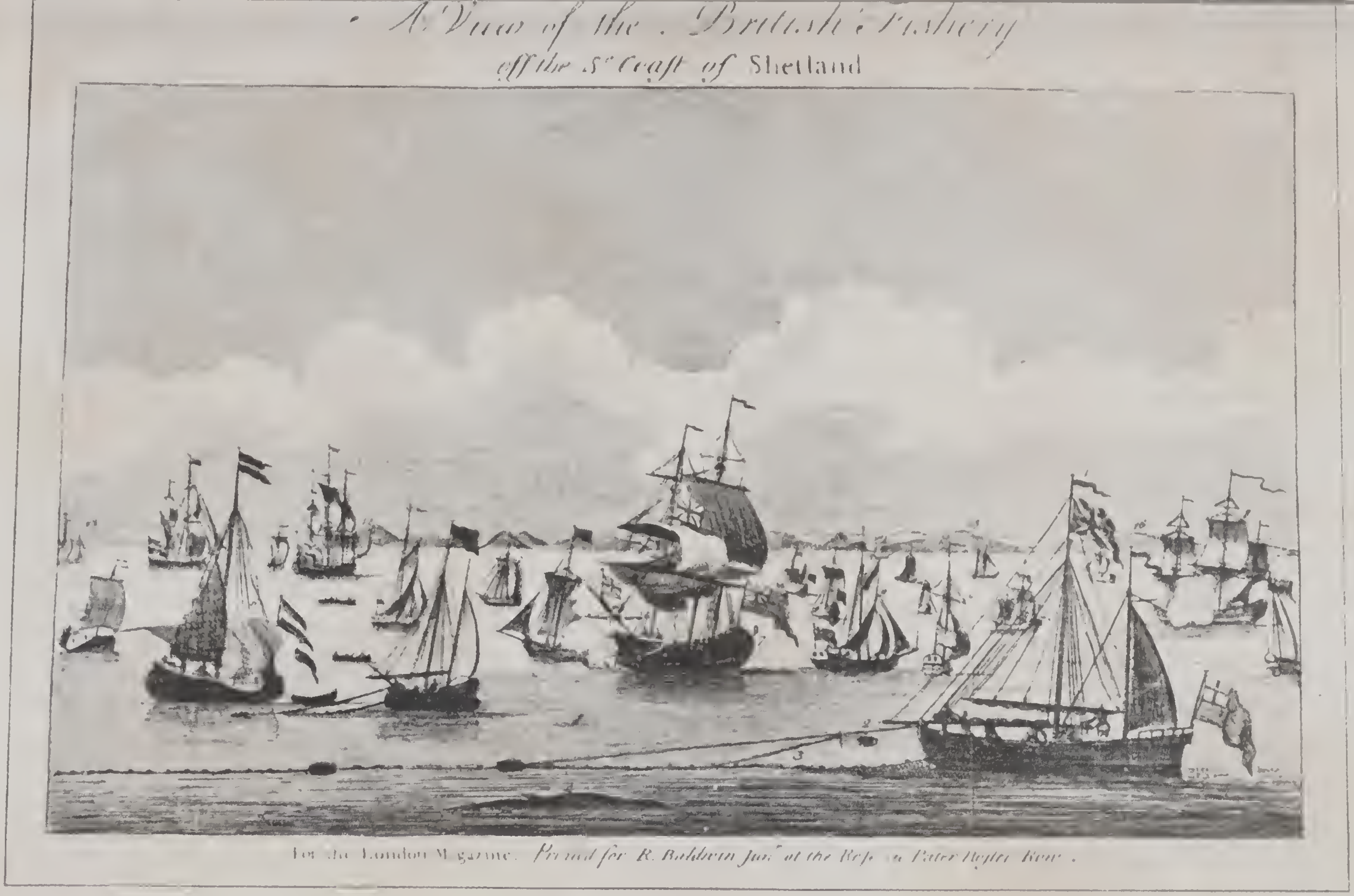
At Aberdeen, which was famous for its barrelled salt pork and salmon, he observes that 'the Herring Fishing is . . . common . . . to all this shore of Scotland . . . and is like the Indies at their door . . . the merchants of Aberdeen cannot omit the benefit and with this they are able to carry on their trade to Dantzick and Koningsbergh, Riga and Narva, Wyburgh [Viborg] and Stockholm to the more advantage.'

Farther north still, in Caithness, probably at Wick, he discovered a colony of English, who took and cured herrings, as well as white fish, all of which teemed in the seas about, in apparently inexhaustible amounts. Along the Firth of Clyde, too, from about Ballantrae northwards, particularly at Irvine and Greenock, he found herrings being caught for the merchants of Glasgow.

The Union depressed the fisheries of Scotland by introducing the restrictive English duties on salt, etc. Moreover the bounty system put a premium on the building of large vessels of the type required by the Dutch fishing for long periods 400 miles from home, but not the most suitable for the Scottish lochs, etc.

Adam Smith, the apostle of *laissez-faire*, who was naturally against interference with 'natural', economic laws, said that 'it has been too common for vessels to fit out for the sole purpose of catching, not the fish, but the bounty' (*The Wealth of Nations*, 1776). Doubts as to the value of the bounty scheme to the development of the fisheries or as a nursery for seamen were shared even by Scottish writers at the turn of the century.[11]

However, under the bounty scheme the number of busses employed in the Scottish fishery grew steadily from three be-


A View of the British Fishery
off the S.e Coast of Shetland
For the London Magazine. Printed for R. Baldwin Junr. at the Rose in Pater Noster Row.

By courtesy of Staples Press Ltd.

PLATE 2.—Seventeenth-century British herring fishery off Shetland. *From* The Sea Fisheries *by J. T. Jenkins.*

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PLATE 3.—Barrel of salt herrings after packing.

tween 1751 and 1756 to 293 between 1787 and 1798, while the number of barrels cured yearly rose from 264 to 59,000.

Samuel Johnson and Boswell commented on the 'bounty busses' during their tour of the Western Islands. Thus, on 8th September, 1773, they hoped to get a lift from Skye across the Sound of Raasay in 'one of the boats belonging to the fleet of bounty busses then on the coast.'[12]

It seems that the year selected by Adam Smith for illustration, 1759, was the only year in which the fishery was a complete failure, three busses with forty-one men yielding only four barrels of herring. However, there was considerable competition in the export market. The Scottish export fell from 36,365 barrels in 1776 to 12,122 in 1782, in which year England exported only 14,268 barrels. In 1784 there were still 275 Dutch and other busses fishing off Shetland.

The Swedes were also active in the herring fishery in the latter half of the century, and were conveniently situated for capturing the Baltic market. In 1764 they also exported 20,000 barrels from Gothenberg to Ireland and thence to the British colonies. In 1781 they exported 130,000 barrels, and in 1782, 200,000 barrels left Gothenberg. Surplus fish were boiled down for oil, 1¼ million gallons (about 5,000 tons) being produced in one year.

Further attempts were made towards the end of the century to stimulate fisheries through the 'British Society for Extending the Fisheries and Improving the Sea Coasts of this Kingdom' founded in 1786. One of the moving spirits in this was a one-time crony of James Boswell, Mr. George Dempster (1732–1818) of Dunnichen, near Forfar, for which he was M.P. until 1790. The Society, which was share-holding, was particularly interested in the Highlands. In 1788, 'a great quantity of red herrings were cured at Isle Martin' at the entrance to Loch Broom and just after this the Society gave £720 to Robert Melvill for the erection of 'smoking houses', etc. for cod and herring at Ullapool, which the Society was developing by setting up 'tweed mills and the like.'[33] Later the 'British Society for the Encouragement of the Herring Fisheries' gave premiums to persons distinguishing themselves by catching and curing the fish.

In the last decade of the century when herring became abundant in the Firth of Forth, a fishing fleet from all over, including Bristol and Ireland, assembled on the Fife coast and smoke houses and curing yards were established there.[7]

About this time East Anglia too began to revive. In 1791 about fifty vessels were fitted out from Yarmouth and between thirty and forty from Lowestoft. The fishing commenced on 20th September and continued into December. The fish were salted in the hold and brought home for curing red. The boats stayed at sea for three, four, or even six days.

The Isle of Man fishery also expanded rapidly about this time. Whereas during the period of five years preceding 1771, only 7,667 barrels of salt herring had been exported, in the same period preceding 1782, 104,537 barrels were exported. The salted products were sent to the West Indian plantations, but they fetched poor prices on the Continent and pickled herrings sold on the home market were often partly decomposed owing to faulty methods of preparation.[14] It will be noted that the fishing and curing depended in large measure on exports, rather than home consumption.

The Highland Society of Scotland published in 1803 in its *Transactions* a number of prize essays on various aspects of the herring industry, including an 'Account of the Dutch Herring Fishery communicated by Two Dutchmen to Cosmo Gordon, Esq. of the Custom House of London, and by him to the Highland Society; to which is Added the Placard or Ordinance by the States of Holland and West Friesland respecting the Dutch Herring Fishery,' which included a great deal of detail on the Dutch curing methods.

In 1805 the Society of Arts offered a reward for 'curing herrings by the Dutch method.' In 1819 and 1820, J. F. Denovan of Leith got rewards of 50 guineas and £50 respectively for his success in obtaining the assistance of experienced Dutch curers in catching and curing herrings on the west coast of Scotland to produce a commodity equal to the Dutch cure. These developments mark the beginning of the rise of the Scottish to become for a time the greatest herring fishing nation in the world.

In 1808 a further Act was passed 'for the further and better regulation of the British White Herring Fishery', establishing Commissioners to brand herrings into 'full', '*matje*', '*schotten*', etc.

Until 1815, 2*s*. per barrel was paid by the Scottish Fishery Board for herring cured and packed in accordance with the regulations prescribed by the Board. In addition, the sum of 2*s*. 8*d*. was paid on each barrel of herring exported. To prevent fraud, the barrels on which bounty had been paid were branded with a 'red-hot iron in large, legible, conspicuous characters,' denoting the day on which the fish were cured, and that they were cured gutted, with a mark to identify the curer. The word 'FULL' was burnt underneath a crown if the fish were full of roe, but just the bare crown if they were 'shotten'.

This time the herring curing which had increased from 90,000 barrels in 1809 to 444,000 in 1830 had become so well established that the fishing did not collapse when bounties were withdrawn in 1829. Perhaps the repeal of the irksome salt duties in 1825 also contributed to the prosperity of the industry. Moreover, it could be claimed this time that the system of inspection had resulted in a great improvement in the quality of the Scottish cure. 'At the commencement', said the Commissioners, 'the barrels were variable and poorly constructed so that the pickle, without which herrings cannot be properly cured, could not be retained; the herrings were generally cured ungutted, and often in bulk, without any attempt being made to extract the blood or entrails, and when the operation of gutting was performed, it was often so long delayed, and from being done with the finger and thumb so imperfectly executed, as to be of little use; the herrings were often left exposed to the weather on the ground, until it was found convenient to put them into casks . . . which were often in great measure filled with salt instead of herrings.' Whereas in 1827, 'the barrels are uniform . . . substantial and workmanlike . . . and the tightness of the cask secured . . . The herrings as soon as they are brought on shore are deposited in gutting boxes, covered with shades . . . are seldom cured ungutted or in bulk, except when intended to be made into red herrings . . . are gutted with a knife, and regularly packed into barrels with a small portion of salt strewn between each layer, within twenty-four hours after they are caught . . . The minimum weight in each barrel is fixed by law, the barrels filled with pickle . . . and as a security to the public, and a check on fraud and negligence' branded with the date of cure, curer's name and address and the name of the inspector.

In addition, 'agriculture had been benefitted and waste land reclaimed by the use of the offal of the fish as manure (arising from) the bounty being confined to gutted fish alone.'

Some writers did not take such a sanguine view as the Commissioners of the status of the Scottish herring curing industry at that time. Lord Teignmouth's *Sketches of the Coast and Islands of Scotland and the Isle of Man*, published in 1826, declared that: 'The bounty attracts adventurers unacquainted with the process of curing, adopting the practice of packing the fish in the open air, and endeavouring to correct the ill effects produced by sun and rain by large quantities of salt.' He noted, with approval, a curing establishment on Loch Erribol, near Cape Wrath, where the Dutch procedure was strictly adhered to 'as the inferior process used at Wick and other ports of Scotland would be inapplicable to fish in the early season' (when fatty and full of feed?). 'Every particle of unnecessary matter is removed and the fish is so closely packed as to exclude air; and, as the cleansing is so complete as to remove all matter that would generate noxious effluvia, very little salt is necessary' (an exaggeration, surely!). 'The fish are, when packed, laid on their backs, not on their sides, and the barrels are of oak wood; those used at Wick are chiefly of birch, produced from the coppices of the Wester Coast.'[15]

SALT LEGISLATION

Throughout the whole period in which the British herring fishery was being encouraged by various bounties, etc., there were restrictions on the import and production of salt which considerably hindered development. Elizabeth I introduced a salt monopoly and substantial royalties to the Crown were written into the patents, although it seems that these measures were never effectively established. Excise arrangements also existed under the Commonwealth. However, it was under William III in 1697–8, when an additional duty of 2*s*. 4*d*. per bushel of 56 lb. was imposed that the period of penal taxation was initiated. Although the eighth article of the Treaty of Union between England and Scotland in 1707 specifically granted Scotland certain exemptions from salt taxation, these agreements were abrogated later in the century, and there were all sorts of anomalies.[16] On the other hand, it was the fiscal policy embodied in an Act of 1712 which put an end to the free import of salt into Scotland and thus gave rise to the development of local fisheries, such as the 'haaf', or 'deep sea' fishery off the Shetland Isles[17] (*see* p. 159 *et seq.*).

By 1782, the duty on salt was about £30 per ton, which amounted to 4,000 per cent *ad valorem*. To enforce this and prevent smuggling, there were numerous hampering restrictions on the use of salt, the effect of which was practically to cripple the fish trade. Although a 'drawback' of duty-free salt was allowed for fish curing, the procedure for accounting for this was especially tedious on the west coast of Scotland, where at the same time smuggling from Ireland was most flourishing.

A writer in 1784 says of the inhabitants of the Western Highlands and Islands,[33] 'The laws which particularly oppress them are the salt laws: and if ever it is expected to make the fisheries flourish, these must undergo a radical change.' Although at that time salt to be used for curing fish was free of import duty, 'all importers of foreign salt were required first to land it at a custom house, where it was to be carefully weighed by the proper officers, and the importer either to pay the duty, or to enter it for the purpose of curing fish; and in that case to give bond, with two sufficient securities, either to pay the excise duty of ten shillings per bushel, or to account for the salt under the penalty of twenty shillings for each bushel. In consequence of this bond, he must either produce the salt itself at that custom house on or before the fifth of April thereafter, or cured fish in such quantities as are sufficient to exhaust the whole of that salt, which fish he is obliged to declare upon oath, were cured with the salt for which he had granted bond.' Only herring might be cured with the exempted salt, and no herring could be sold unless first entered at the custom house, which involved the payment of another duty; nor could they be reshipped after having been landed without an order from the custom house officer. Even fish for domestic consumption had to be unshipped and unpacked and displayed to account for practically every particle of the smallest quantity of salt used before duty would be refunded. This was made all the more awkward by the paucity of custom houses on the west coast of Scotland, and the long distances and waste of time involved.

In 1784, Archibald Cochrane, the ninth Earl of Dundonald (1749–1831), a pioneer of chemical industry in Britain,[18] who had inherited the Culross salt pans, now rather derelict, published a pamphlet entitled: *Thoughts on the Manufacture and Trade of Salt, the Herring Fisheries, etc.*,[7] which provides some interesting sidelights. He complained of the lack of attention paid in Britain to the purity of the salt used for curing herrings and the slipshod way in which the fish were caught and cured. He drew attention to the decline in the salt industry. Salt manufacture on the east coast had declined. Thus at North and South Shields, despite their proximity to the coalfields, the number of salt pans once 200, had fallen to twenty, due to the greater power of the sun on the south coast and the increasing use of rock salt on the west coast. At Lymington, on the Solent, sea water was still being evaporated from shallow ponds and afterwards boiled down with coal brought all the way from Newcastle and Sunderland. At Liverpool, rock salt was dissolved in sea water to make the strongest possible brine which was then evaporated. Dundonald pointed out the artificiality of the restrictions. Thus, the importation of salt from Northwich was only permitted in the case of the ports of England, at Swansea, Holyhead, Lawnmarsh and such places as were within ten miles of the salt pans; elsewhere its use was prohibited, but it could be exported free of duty to Ireland. This led to widespread smuggling, although fish cured with smuggled salt could not, of course, be sold on the open market.

These restrictions resulted in the loss of much of the herring caught and had put an end to the Iceland fishing. At this time, salt was also becoming an important raw material for chemical industry. Dundonald himself was interested in a process for the manufacture of soda from salt. The annual consumption of salt in England at that time for all purposes was about 4,200,000 bushels, taxed at 3*s*. 4*d*. per bushel, which with a population of 7 millions worked out at 33½ lb. per head. Scotland, with a population of about 1½ millions, consumed a further 900,000 tons, about half of which, Dundonald estimated, was smuggled. He proposed the entire abolition of the restrictions and duties on salt.

A committee appointed by Parliament in 1785 reported that the system of salt taxation was one of the principal reasons why the fisheries of Great Britain had never been carried to the height of prosperity and advantage of which they were capable.

However, 'In consequence of absurd laws . . . the fish they now catch are few in number in comparison of what they might be, and cost perhaps double the price to those who have them to sell, that they might be offered for in other circumstances.'

In July 1785, Pitt conceded permission to fishing vessels to catch and cure other kinds of fish besides herring when fishing for the latter.

Another Parliamentary Committee of 1798–1800 reported that the most considerable salesmen of London made a constant practice of paying the duty on salt used in the fishery, as being on the whole less burdensome than a compliance with the regulations for the use of duty-free salt. They observed that the weight of the duty was such that in general the fishermen chose rather to throw the fish overboard than to cure it, taking to the market only such fish as could be landed alive or fresh. A substantial part of the supply of fish intended for London had hitherto been destroyed in this manner.

The Napoleonic wars forced the duty up to 15*s.* per bushel in the early years of the nineteenth century, and salt in Glasgow was costing £1 2*s.* 3*d.* per bushel (i.e. £44 10*s.* per ton or 5*d.* per lb.). Such a penal system of taxation was now an intolerable handicap to the flourishing chemical industry and it was on account of pressure from this interest, rather than on account of the fishery industry, that repeal of the salt acts had to be reconsidered in 1822.

However, it was not until 1824 that the duties were first alleviated and in 1825 finally abolished.[19] The price of salt thereupon fell from £32 to £1 per ton within the next decade, and to 12*s.* per ton by 1880. At the same time there was a great increase in production and consumption, largely on account of the growth of the chemical industry.

A tax on salt was until recently an important source of revenue to many exchequers. It disappeared in Norway in 1844 and in Portugal in 1848, both, it is interesting to note, important salt fish producing countries. As late as 1915, nearly every other country imposed some form of salt tax.

NINETEENTH CENTURY

As a result of 'free trade', the Scottish herring industry, based on the drifter and salt curing for export, expanded enormously in the second half of the nineteenth century and up to 1914. In 1839, when Christian Ployen, the Danish Commandant in the Faroe Islands visited Scotland, he found the herring fishing in Aberdeen not more than ten or fifteen years old. 'Most of the herrings caught at Aberdeen are smoked, like what are called in Denmark, Dutch herrings [*bokking*?], and are sent by steamer to London; which . . . requires a sure market and steady communications, as smoked herring does not keep long.'[20]

In Shetland, the local herring fishing, although a new industry, was already becoming important.

Various classes of boat prosecuted this fishery. The firm of Hay & Ogilvy of Lerwick had about one hundred such boats, each carrying about five men, dispersed among the different stations. Fish were caught on overnight trips and salting was begun immediately it was landed. The fish were allowed to fall from the cran measure straight into a thick layer of salt on the bottom of a large wooden box made of boards and planks. At every fresh cran-full, the fish was stirred with a wooden shovel to mix with the salt. As soon as the box was full enough, 'gipping' commenced, the guts being kept for manure. After gutting, another worker rubbed the fish over with salt, yet another laid them in a barrel, back downwards, in even rows with the requisite quantity of salt between the layers. After standing for two days and nights, the fish were repacked, having so shrunken that three barrels now filled two. The barrels were headed up and after fourteen days turned and opened, and the fish packed closer together if necessary. Ployen noted, however, a marked difference between the flavour of herring cured by the Shetland and those cured by the Dutch who had assembled 130 busses in Bressay Sound that year on 24th June as usual. He boarded one of them and commented that 'the most extreme cleanliness prevailed in every part of the vessel.'

The Dutch made no secret of their method and 'lay particular stress on the circumstance that, with them, the herring, immediately on being caught, is put under hatches, where it is not exposed to the risk of being crushed or trampled on, nor to the action of the atmosphere—as the fattest and best fish are most apt to spoil.'

Proposals to discontinue the Government branding were made in 1855 and again in 1863. However, in the interests of maintaining standards of quality the branding system of government inspection has been retained until the present day. A protagonist in 1849 points out already that the Crown Brand commanded confidence in foreign markets. 'Orders for Pesth in Hungary could and have been given under the brand with the same confidence and satisfactory result as if the buyer had been upon the spot.'[21] As a result the writer claims that although the Dutch by salting at sea aboard the fishing vessel have the power to bleed fish immediately after they are caught, 'the Scotch cure has undoubtedly assumed first place' although a shore-based fishery. Nevertheless, according to a pamphleteer of 1885, 'the Dutch fishermen catch quality in preference to quantity. The Scotch fishermen catch quantity in preference to quality . . . delighting in great hauls'[22] and taking less care to select only good-sized herrings.

Even so, as late as 1882 it was again remarked that all was not as it ought to be in the Highlands and Islands herring curing industry. 'Fish in the early part of the season will not cure and herring cured in Lewis or Wick before the middle of July are commonly, if not uneatable, so poor in a month or two that they are spoiled for good markets.'[15] 'The fish may be and often must be, a long time in reaching port, when they are carried to the large troughs of the curers and tumbled in.' After gutting, 'rousing' with salt and packing in the usual manner, 'The fish now depend for their quality on their original condition, upon the rapid transfer from the water to the tubs, on the care of the gutters, the rejection of all broken or injured fish and the proper seasoning of the barrels, as well as upon their being immediately covered on completion.' The British practices are compared unfavourably with the meticulous attention to detail demanded from the Dutch operators for first-class herrings, whether on board vessel or on shore. 'The pickle that was placed in the packing-tub was carefully passed through a sieve to clean it from scales and other impurities, and into these barrels of clean pickle only so many herrings at a time were thrown as might be lifted with the hands, so that they might get proper justice and not be hurriedly heaped. So soon as seven barrels of herrings were put into the tubs, the pickle was again sieved . . . The herrings, when removed from the pickle, were placed upon draining trays to allow the pickle to run off. In the meantime the barrels were filled up with pickle to season them, and before filling, the plugs were knocked out, so that this pickle should be thoroughly removed. The herrings were then packed down as closely as possible, and every crevice filled up. Four barrels of salt were used to twelve barrels of herring. In heading on, the herrings were formerly pressed down with the feet, so as to be absolutely tight, exclude air, and prevent shifting and breaking the fish.' The writer again pointed out the distinction made between fish taken before and after 24th July and again those taken after 26th August (on account of distinct differences in fattiness and maturity), and that various sorts of inferior and unsuitable fish were rejected. 'Those working in the open air were obliged to cease work immediately it commenced to rain.' The use of a knife in removing gills and viscera so as to free the fish of blood more completely was said to account for the whiter appearance of the best Dutch cured fish, the blackness caused by the coagulation of the blood being absent. It was the want of this meticulous attention to detail which still made the Scotch cure inferior to that of the Dutch at its best.

By 1853, 10,000 lasts (i.e. 20,000 tons) were cured annually in Scotland, using 10,000 tons of salt and soon after this the home market for fresh herrings consequent upon the improved transport and the use of ice began to displace that for salted herrings. Nevertheless, the export market continued to expand and the annual catch had reached 100,000 tons by 1889.

Peterhead, which was described as a 'fisher town' as early as 1587 in the Charter granted by James VI, along with Fraserburgh, became two of the chief Scottish ports. Whereas in 1840 it landed 48,595 crans (about 9,000 tons), the catch had approximately trebled by 1890. Soon after this the change over from sailing- to steam-drifter (*see* p. 272) permitted further increases in production so that by 1913, the total catch had reached nearly 600,000 tons. Yarmouth and Lowestoft had a large share of this catch, although the industry was still manned, and 'womanned', chiefly by Scots, who followed the fishing down to East Anglia in the autumn.

These years immediately prior to World War I were peak years for the British herring curing industry, which attained a level of business and prosperity never again to be approached. About 73 per cent of this was exported as salt cure in more than 2½ million barrels chiefly to Russia, Poland, and Germany. A further 12 per cent was 'klondyked', i.e. sprinkled with salt and ice in boxes and shipped quickly, chiefly to Germany for making delicatessen and hot smoking to produce *Bücklinge*. Six per cent were 'redded' mostly at Yarmouth still for the Mediterranean and the Levant. Only 12 per cent was home consumed, as fresh herrings, bloaters, and kippers.

Libau in Latvia was the chief centre for import of salt herrings, taking about 600,000 barrels annually, of which 90 to 95 per cent were of British origin. Thence, they were distributed by rail over the Russian Empire in wagons, many of which had double walls, with the space between full of sawdust. Mostly they went into Lithuania and central Russia including Moscow, but some went as far as Baku, Tashkent, which took fourteen days, and even over the Trans-Siberian Railway to Vladivostok, the freight rate for which was £150 for a truck load of sixty-five barrels.

Königsberg distributed about 500,000 barrels, 55 per cent of which came from Britain, mostly to central and eastern Poland, particularly Warsaw, and western Ukraine, including Odessa. One curing firm at Portsoy on the Moray Firth is reported one year to have sold its entire cure of 46,000 barrels to a dealer at Königsberg, who in turn railed them all to Kiev. Stettin also took about 550,000 barrels, of which again 80 to 85 per cent came from Britain, most of which were disposed of to central and eastern Germany.

Hamburg took about 250,000 barrels of the somewhat less salty *matje* cure made mostly from the small, fatty, immature Scottish west coast herring. It dominated this trade because of its ample cold storage facilities which were imperative for the successful distribution of this relatively more perishable product, which went to all parts of Poland and some of the western provinces of Russia.

Of the relatively smaller ports, St. Petersburg dealt with 200,000 barrels, mostly *matjes* from Buncrana and Downings Bay in Ireland and Castlebay and Stornoway in the Outer

Hebrides, which were consumed by its own population of about a million people and the nearby Imperial cities of Peterhof and Gatzina. Riga took 160,000 barrels mainly for Latvia and a part of Estonia, Reval supplying the remainder of that country. Danzig took 150,000 barrels for parts of Poland and Roumania, although after the war it assumed much greater importance as the main port, along with Gdynia, of the newly created Poland.

In addition, much smaller shipments went to Abo and Helsingfors in Finland, Odessa, and Nicolaiev on the Black Sea and also to New York and Boston.[23]

From the middle of the nineteenth century onwards, the Dutch too were beginning to revive their cured herring exports, which increased from an average of 20,000 barrels a year during the decade 1861–70 to 620,000 in 1910.

An account in 1876 shows that the Dutch fishing at that time was proceeding in much the same traditional manner as in former centuries.[15] Two hundred and fifty 'loggers' and 'hookes' were engaged in catching and salting herring at sea principally for home consumption. They were mostly two-masted schooner-rigged craft of about eighty tons with a crew of fifteen.

The fleet sailed on the last day of May for the summer herring grounds, lying between 53° and 59° N. They were accompanied by five fast sailing yachts—the *jägers*, one of which received every day what each fishing boat had caught, pickled, and barrelled. She then crowded on all sail for Vlaardingen, where watchmen in the church steeple looked for her approach. The cargo was auctioned at once to the highest bidder. The first arrivals, about the last week of June, fetched as high as 450 guilders or £37 10*s*. Dealers repickled their purchases under their own private brand, made by secret processes which were jealously guarded. They were dispatched to special customers packed in small barrels of six, twelve, eighteen or twenty-four fish. The choicest fish sold at one guilder apiece—a barrel of one dozen thus costing the equivalent of a sovereign. Each successive cargo was disposed of in the same way, the fishmongers announcing a new arrival by hanging over their shop a basket decorated with ears of corn, bits of silk, and tinsel. In July, the price fell to six guilders per dozen, and by the beginning of August to three. The season was over in September when the price fell by half again to about twopence each for the best quality.

HERRING CURING TO-DAY

Herrings salted and packed in barrels in their brine pickle, using precisely the same method as that developed by the Dutch in the Middle Ages, are still much relished in central and northern Europe.

Fish taken fresh from the vessels after an overnight voyage are first given a preliminary sprinkling with salt and 'roused', i.e. turned over and over a few times, in the 'farlands', or receiving boxes, to remove surface slime, thus facilitating handling, and also to commence the salting process.[24, 25]

They are then 'gibbed' to remove the gills and long gut, but leaving the roe and milt and the rest of the viscera. The presence of the latter is held by some people to contribute to the characteristic flavour of the final cured product, owing to the action of enzymes diffusing from certain of the organs. Certainly bacteria play an essential part in the chemical changes involved in 'maturation'.

The 'gipping' is still carried out mostly by hand, but in recent years, machines have been developed which not only appear to carry out the operation just as efficiently and more quickly, but in addition require only unskilled labour for their operation. The latter consideration is perhaps the most important because the old time 'fisher-lass' is fast dying out, in Britain at least, partly as a result of the experiences of the years of depression in the industry and partly as a result of the competition of more congenial employments.

A small quantity of fish used to be 'rough-packed' without 'gipping' at all, but this product is generally regarded as very inferior.

After 'gipping', the fish are packed into barrels with salt between layers. Water is drawn out of the fish as a result of the complicated osmotic changes,[26] forming a pickle in the barrel—the 'blood pickle'—and in a day or two the fish shrink and more fish, at the same stage of cure, are added to the barrel. After eight to ten days when the process is complete, the blood pickle is run off at the bung hole, the barrel filled tightly with cured fish, and the spaces between filled with blood pickle, which is presumed to contain natural antioxidants, since the addition of fresh pickle at this stage is said to promote rancidity of the fat.

The barrels need to be absolutely brine tight, otherwise if there is any leakage, air gets into the barrel and the fish rapidly become rancid. The trade of the cooper who makes the barrels requires considerable skill and experience. Swedish spruce is the species of wood favoured for their construction (*see* Plate 3).

The Scottish Home Department Fisheries Division, which has now replaced the Fishery Board for Scotland, still has fishery officers authorized to inspect the cure and to mark barrels with a stamp signifying the quality of the herring and the fact that the barrels are of the correct construction and the herring have been gutted and cured and packed in barrels within twenty-four hours of capture. The Crown Brands are 'Mattie' for young herring not less than 9 in. in extreme length with reproductive organs not yet fully developed, normally caught before 1st July at Shetland or 10th July off the east coast of Scotland; 'Mat. Full' for herring with roe or milt visible at the throat, but not less than 9¼ in. long; and 'Full' and 'Large Full' (La. Full) are full herrings not less than 10¼ and 11¼ in. in length respectively. 'Spent' and 'La. Spent' are empty fish between 9 and 10¼ in. and more than 10¼ in. respectively in extreme length. A barrel is not Crown branded if it is found to contain inferior, e.g. torn or broken fish, numbering fifteen to thirty, depending on the brand, in the original packing or six to twelve after repacking. Actually, however, the brand of firms of repute is usually as reliable as the 'Crown Brand', and even before 1939, the proportion of cured herring submitted for Crown branding was decreasing.

Since 1945, cured herring exports have been negotiated by the Herring Industry Board,* and supplied by a group of firms operating under the name of Associated Herring Merchants, Ltd.

Less salty cures are still made from the smaller, *matje* herring, e.g. at Castlebay, in the Island of Barra at the south end of the Outer Hebrides. The strength of the brine formed in the barrel in this case is about 80 per cent of saturation.

Heavily cured herrings in brine of 90 to 100 per cent saturation keep in good edible condition for three or four months at temperatures of about 60° F., but become inedible after a few more months. To be kept for longer periods, refrigerated storage is required and at about 26.5° F. they keep in excellent condition for at least a year. Lighter cures in a brine of 75 to 80 per cent saturation quickly spoil at 60° F. after a month, but at 26.5° F. they are still in good condition even after a year.

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* The Herring Industry Board was set up in the United Kingdom as a result of the recommendation of the Sea Fish Commission's First Report in 1932. The Board was reconstituted in 1938 and given powers, which have been renewed since the War, to regulate the industry and to take responsibility for research and development.

It used to be thought that wood was, for some unexplained reason, essential for the development of a properly flavoured cure. It has now been proved, however, that a perfectly good cure can be made for example, in enamelled baths.[28] Also that 'nobbed' fish, from which the heads and 'long gut' had been removed by machine as used for canned herring, kept just as well as fish gibbed in the ordinary manner, which seems to dispose of another of the many myths prevalent in the herring trade. This 'nobbed' cure gives a cleaner looking pack and is being produced on an increasing scale by the Norwegians, Dutch and others engaged in the herring trade. An advantage of bulk pickling in vats is that subsequent repacking could be done at leisure in smaller containers, such as lacquered cans, which have been proved to be quite suitable for the purpose. It is felt in some quarters that smaller, more attractive packs might do much to maintain and revive interest in the consumption of pickled herrings. A satisfactory gipping machine has also been developed recently (*see* Plate 4).

Central and northern Europe are still the principal consumers of salt herring. The British export never recovered to its pre-1914 level and still further declined between the wars, partly owing to a foreign competition and trade barriers. Another important reason for the recession is the development of more discriminating palates that no longer relish the bitter, salty, and characteristic flavour now that a greater variety of milder flavoured commodities has been made available, at least in the more advanced countries by the processes and communications of the industrial era. In Scotland, the lower standard of living, combined with poor communications and a greater dependence on fishing, even for subsistence in isolated places, led to a much greater dependence on salt herring, in some places as a staple article of diet until quite recent times. However, even there tastes have changed. A typical contemporary Scottish reaction to salt herrings is given in the following account of a modern writer's upbringing on an Aberdeenshire farm in the early years of the century.*

> 'When I was a boy there was always a seven-course rotation of dinners: on Sunday hot roast; on Monday cold roast; on Tuesday stoved tatties with the orrals of the beef. On Friday there was always a milk dinner—milk broth followed by rice pudding; on Saturday, fish brought from the town on the previous day. Wednesday and Thursday were problem days, and on one or other we usually had salt herrings. My grandmother bought them by the barrel and for years kept the barrel in the back scullery, till everyone complained so bitterly about the smell that they were put out to the workshop among the blunt saws and rusty chisels. As the saws grew blunter and the chisels more rusty, my grandfather maintained it was the herrings that did it . . . Now the method of preparing them for the table was this. On a Tuesday afternoon my grandmother took enough to make a dinner and enclosed them in a wire cage that had once been a mousetrap. Then we took them to the nearest stream and anchored the cage at the bottom of a little pool and left it there for a day or two. We then brought home the fish which were first boiled and then baked and served with potatoes and a thick coating of mustard sauce. They tasted, to me, like old dish cloths full of bones and impregnated with salt: I am sure of it, for I can taste them yet, after so many years. One of the first things I really understood in the history books was that skirmish in the Low Countries called the Battle of the Herrings. I could understand the salt herrings being used as lethal weapons and soldiers dying, salted, as you might say, to death.'

Since World War II, there has been a further steep decline in the home production of salt herrings as export markets suffered a further shrinkage, although recent resumption of contracts with the U.S.S.R. has led to a temporary revival. The Scottish cure in 1952 of 137,000 barrels (about 20,000 tons) was double that of the previous year.

Dates for commencing curing of fish caught in certain areas are now prescribed by the Herring Industry Board. The object

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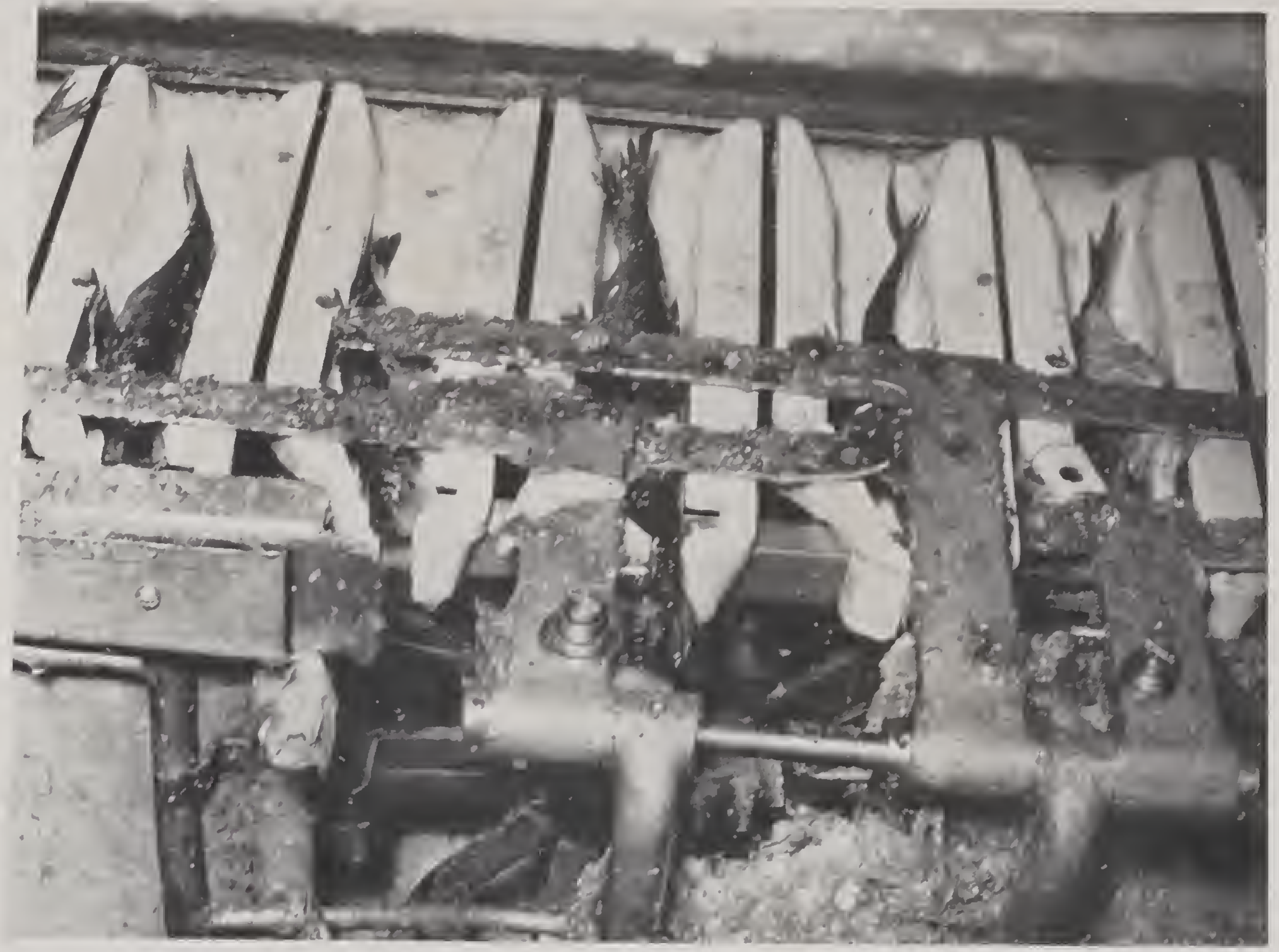
*Allan, J. R. *The North East Lowlands of Scotland* (London, Robert Hale Ltd. 1952).



By courtesy of Bloomfields Ltd. Copyright Leonard Hill Limited.

PLATE 4.—Herring gutting machine.

of this is, as in the sixteenth century, to ensure that the class of fish caught and its fattiness and general condition are as required by the markets to be supplied. Whilst the British export trade has been declining, however, Holland has now partially re-established its old historical position as a curer and exporter of North Sea herrings. The total amount of salted herring and similar species produced is now about the same as before World War II, but the proportion Britain produced has declined whereas the production of Norway and Sweden has increased. The exports of Norway in particular to Russia and Poland and Eastern Germany, formerly the U.K.'s chief markets, have also increased considerably) *see also* Chapter 14).

The total world production of salt herring and similar species is now about 500,000 tons annually. The Dutch herring exports are now several times greater than those of Britain.[27] In 1951 their production is reported to have been about 530,000 barrels (about 100,000 tons), including 200,000 of *matjes*, chiefly consumed in Holland and Belgium, and in addition about 90,000 barrels were smoked, ungutted, as 'reds' and sent to the Mediterranean.

An F.A.O.* meeting held to discuss the problems of the herring trade at The Hague in 1949 declared that 'from evidence submitted, it appears that, whereas the demand for salted herring is declining, the consumer is showing more interest in soft cures in the field of pickling, marinating, smoking, etc.' This seems to fit in with the general picture that with the improvement of communications which renders hard curing for preservation less necessary, and with the increasing standards of living, associated with industrialization, a taste is developed for 'milder' cured products. This tendency leads, too, of course, to a preference for 'fresh', uncured fish, which have to be distributed rapidly.

KLONDYKING

'Klondyking', a process intermediate between salting and 'freshing', is a short term method of preserving fresh, ungutted herring by sprinkling them with ice and salt and packing in

* The Food and Agriculture Organization of the United Nations (F. A. O.) has a Fisheries Division which has amongst its functions the technical assistance of under-developed countries, the publication of special studies and abstracts of current research work in the field of fisheries technology, as well as the organization of co-operative research in various fish producing areas of the world.

wooden boxes for export. The name presumably derives from the famous Gold Rush of the eighteen-nineties about the time that this trade was first developed. The preservation is probably due more to the low temperature and partial freezing that results from mixing ice and salt than to the bactericidal action of the salt itself.

Considerable quantities of fish can be treated in this way by competent teams of men. The fish are shipped in specially chartered vessels. After loading a ship in, perhaps, thirty-six hours, the journey from, say, Lerwick in the Shetland Islands to the north German ports such as Hamburg and Altona would take about three days, so that the fish would probably be on sale not more than six days after catching. Although not then comparable with fresh herrings owing to the salting as much as to the storage, the fish are quite suitable for hot smoking whole as 'buckling' and for marinating by treatment with vinegar and salt, spices, bay leaves, etc. In this latter form they are incorporated into many of the delicatessen so popular on the Continent of Europe, e.g. Bismarck Herring, *Rollmops*, *Appetit-sild*, and *Gabelbissen* (fork titbits, *Gafelbitar* in Swedish).[29] Probably in the first place, salt pickled herrings were used for these products.

These 'semi-sterile' packs were being produced in Scandinavia for domestic consumption by the middle of the seventeenth century. Sprats particularly were preserved in this way by means of salt and acids, chiefly vinegar, sugar, and spices in wooden kegs. The first commercial manufacture started in 1841. Russia, too, by the beginning of the present century already produced what was called *killo* from sprats after this fashion. To-day, Sweden particularly specializes in these 'semi-conserves', which are prepared in great variety and packed in hermetically sealed cans, without subsequent heat processing. The salt content is usually between 8 and 12 per cent, depending on the type of delicatessen. The acidity develops during storage as proteolysis (i.e. the breakdown of protein to its constituent parts and ultimately to amino acids) gets underway. Preservatives, such as hexamethylene tetramine, are often used now.

German ports on the North Sea and Baltic developed this trade in *Marinaden* in a large way in the latter part of the nineteenth century, obtaining herring for the purpose largely from Britain, Norway and Sweden. They also produced a fried herring product, known as *Bratheringen*, as well as *Bücklinge* (*see* p. 284).

In 1938, the quantities of smoked and marinated fish produced, chiefly from herrings, were 80,000 and 76,000 tons respectively and in 1949, 55,000 and 51,000 tons. Hot smoking is perhaps not so much a method of preservation as a means of giving the fish a flavour, and it has to be sold quickly. *Marinaden* can be kept for some months in cool storage.

NORTH AMERICA

In North American waters, fatty species, similar to herrings, abounded, and in the early part of the nineteenth century these were preserved on a large scale by salting and smoking on the European pattern. In New England, mackerel fishing was developed in the early part of the century and by 1834 there were about a thousand United States ships in the Gulf of St. Lawrence, catching and salting them on board in barrels. A species of herring very similar to our own was also caught in Canadian waters, salted on board and taken home for smoking to produce something similar to 'reds'.

The Canadians at about the same time also began to exploit the mackerel and alewives (or 'river herrings') on an increasing scale. Various laws were passed with a view to improving the product, apparently with little effect. Mackerel were salted in barrels or in the hold in kenches (or piles), which was less satisfactory. By 1832, Nova Scotian alewives had 'almost entirely lost their repute' and were being replaced by Scots herring.[30] These salted fish were disposed of principally to the slave owners of the West Indies plantations. However, even in this market there were complaints about quality. One of these declared that 'alewives taken going down the river after spawning' were 'poison fish', and 'the very worst food that can be given to slaves, as it both disheartens them, keeps them continually murmuring and brings on those scorbutic diseases so common among negroes in that climate.'

A few menhaden were salted in barrels in the eighteen-fifties for the West Indies. In 1884, when Professor G. Brown Goode edited an exhaustive work on *The Fisheries and Fishery Industries of the United States*,[31] salt was still the principal means employed for preserving fatty fish during distribution. Alewives were being preserved by saturation with salt until 'struck' or 'corned' after which they were taken from the brine and hung up for several days in smoke houses for domestic consumption. For shipment into the interior they were either taken out of the first pickle and packed in dry salt, either whole or after removing head and entrails, or else split, packed in dry salt and smoked like a hard cured 'kippered' herring.

The salting of mackerel developed into quite an important industry. They were gutted and split immediately after catching, the flesh of the fish was gashed before salting to increase the speed of penetration. They were then rubbed with salt and packed in barrels flesh side down except at the bottom, care being taken to avoid damaging the fish by thumb marks. The barrels were topped up after five or six days to replace shrinkage, headed up, and stored in the hold.

Small quantities of the species mentioned above, with the exception of menhaden, were still being preserved by salting and smoking in varying degree in the nineteen-twenties as described in detail by Tressler,[32] but even more than in the U.K. with the increase in the use of ice, and freezing, combined with filleting, fatty fish are being neglected in preference for white fish, and are now mostly used for conversion to meal and oil.

CURED FISH INSPECTION OUTSIDE BRITAIN

Even the production of traditional salted dried products demands in the modern age more scientific control and specification of product. Most countries exporting salted and cured fish, whether fatty or non-fatty, now have codes of practice and regulations to which the cures must conform. Thus, in Canada, where there is still quite an important salting industry mostly for export, the Fish Inspection Act of 1927, as subsequently amended from time to time, lays down the procedure to be adopted for pickling and packing herring, mackerel, alewives, and salmon, and for hard-cured smoked round herring (bloaters) and herring fillets. In Norway and Iceland standards are also laid down and government inspectors appointed to enforce them.

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Chapter 6

WHITE FISH SALTING AND DRYING (I)

NORWAY, ICELAND AND NEWFOUNDLAND

IN the early Middle Ages, white fish caught close to our shores was mostly preserved by salting and drying. Unlike herring and similar seasonal migratory species, white fish is practically always there on the sea-bed for the catching, so that the fishery was both more static and more widely diffused than the herring fishery. Almost every hamlet facing the sea was a fishing village. Since no special facilities were required apart from a beach on which to pull up the boats, there was no need for concentration on a few large ports with docks for supplies of ice, coal, etc. as is the case with the much larger ships to-day. After curing, the fish was carried, again by ship, to larger trading ports for distribution and export. Nevertheless, some of the larger fishing ports of to-day have had a long existence; others, once notable, have declined into seaside resorts.

The monks of the Cistercian monasteries who followed in the wake of the Norman Conqueror were magnificent organizers and agriculturalists, even though, as a historian concludes, they were not so remarkable for their piety.[1] In addition to developing sheep farming on the Yorkshire hills, they seemed also to have turned their attention to fish, because the so-called 'Camin' charter of 1160 granted rights connected with 'fishing in the Humber' to the monks of the Abbey of Meaux (or Melsa), not far from where Hull is now.[2]

There were regulations for a fish market in Grimsby as early as 1258,[3] mainly to prevent forestalling and 'regrating', presumably of dried fish, since fresh fish would have been too perishable to 'corner'. 'Morue de Grymsby' (cod is *Gadus morrhua* (Linn.)) is mentioned in the early fourteenth century. The Court at London in 1237 received 'playz de Winchelsee' and 'merlyng de Rye', i.e. whiting. 'Well-vessels' seem to have been in use to keep fish alive.

The Memorials of Fountains Abbey in Yorkshire for 1446–58 record that *pisc. sals.* had been obtained from 'Scarburgh', the inhabitants of which were forbidden by an Ordinance of 1485 to dry fish in the King's street or in the lanes outside their tenures under forfeiture of 12*d*.[4] The Ordinances of the Fishmongers of York refer to strangers of 'Scardeburgh', 'Whitteby' and 'Hertilpole' selling 'outher salt fyshe or herring white or rede or any maner of vitaile that pertains to fishmongercraft.' In 1304, Newcastle was asked for salt haddocks and cod to feed the Scots King and his court at St. Andrews.

At Hull in 1535, the fish trade was clearly of some importance, since an Act of Parliament was passed to regulate it. Barking was another well-known fishing centre, within easy access of the London market (*see* p. 43). In 1349, some 'Berkying' and 'Grenewyche' fishermen who had been fishing with nets set in the Thames on the east side of London Bridge were convicted of catching undersized fish. In 1406, nets near the mouth of the river belonging to Barking fishermen were impounded by the authorities and removed further up the Thames, although on that occasion the disturbance provoked resulted in their being returned to the owners.[5]

The coasts of Devon and Cornwall were one of the most productive fishing grounds of north-west Europe in the Middle Ages.[1] The fishing ports of Penzance, Padstow, Looe, Perranporth and St. Ives, were flourishing centres of industry.

The chief varieties of white fish were the cod family, of which the most highly priced were pollack, scalpin (whiting) and millwell or mulvell, probably cod, cf. French *merluche* for dried fish generally, whether cod, hake or haddock. Hake, always a predominantly west coast fish, was held in great esteem.

'Lochefisshe', sold at Blakeney fish fair in 1357 in three sorts, 'lob', ling and cod, were almost certainly some sort of 'stockfish', wind dried without salt.[3] 'Orgeys', also mentioned in the Blakeney regulations were 'fish larger than lob'. The origin and meaning of some of these terms is obscure. Unspecified 'pecys of salt fisch' are frequently mentioned in merchants' account books. 'Poor John', which was chiefly small salted cod or hake, seems to have been regarded by Shakespeare as poor fare, if one can judge from *The Tempest*, Act II, Scene 2, where it is suspected of causing the 'ancient and fish-like smell' emanating from Caliban. 'Haburden', sometimes written 'haberdine' (*see* p. 36) and apparently associated with Labourd (a Basque region) and nothing at all to do with Aberdeen (cf. Dutch *labberdaan* or *abberdaan*, synonymous with *Zoutevisch*) was hard-dried salt cod.[7]

Ling, although a definite species distinct from cod, was a term used for salt fish generally, as shown for example, by the following extract:

> 'Lings perhaps looks for great extolling, being counted the Beefe of the sea, and standing every fish day (as a cold supporter) at my Lord Mayor's table; yet it is nothing but a long cod; whereof the greater sised is called Organe Ling and the other Codling, because it is not longer than a Cod, and yet hath the taste of Ling: whilst it is new it is called Green-Fish; when it is salted it is called Ling.'

More likely, of course, 'codling' was the diminutive of 'cod' and nothing to do with 'ling'. Moreover, 'green-fish' seems to have been wet salted cod, that after drying became 'ling'. Shakespeare apparently had no great opinion of 'old ling' (*see All's Well that Ends Well*, III, 2).

'Mud fish', a name that suggests no particular regard for the commodity, is met with as early as 1502 in the court rolls of Maldon in Essex, and is mentioned again in the middle of the same century in the household account books of Sir William Petre of Ingatestone Hall. It seems to have been a variety of 'green-fish'.[8]

Baccalao is Spanish for dried, salt cod. A Dutch word, *baccalauw*, was synonymous with *Kabeljauw*, that is still the word for cod. It may have been derived from Latin *baculum* (=a stick) and in that case it would be cognate with 'stockfish'. However, 'stockfish' seems more likely to have been derived from the sticks or poles on which it was dried. Unless there is confusion in contemporary accounts or in those of historians, 'stockfish' seems sometimes to have been salted as well as dried, and it is possible that it was used as a generic term for all fish dried in the 'round' or partly severed state—sometimes with the head on—as distinct from the much improved cleaned and headed 'salt fish' or 'ling' from which the backbone had been removed after splitting right down the middle (*see* top right-hand corner of Frontispiece). According to Bristol records in 1471, stockfish at £5 per last (of twelve barrels) was only about half the value of salt fish. The accounts of the *Mary Walsingham* of Dunwich, owned by Henry Tooley of Ipswich, showed that in 1538 dried cod were worth 34*s*. 4*d*. per 100, whereas ling, presumably salted, fetched 90*s*. per 100. Again, in the fifteen-eighties, stockfish sold for £12 per last, rising to £20 by 1600, whilst salted ling at £3 rising to £5 5*s*. per cwt., was much dearer. Stockfish was certainly not highly regarded by Falstaff who uses the word as a term of abuse (*I Henry IV* II, 4). Turbot and plaice were also salted and 'hound fish', presumably dogfish, is mentioned.

Bristol was the *entrepôt* of much of this salted and dried fish. In 1377 with a population of 9,500, it was the third town in England next to London, 35,000, and York, 11,000, Plymouth coming fourth with 7,000. The discovery of America gave the south-west ports a further fillip, so that by the end of the seventeenth century, Bristol was now the second largest town with a population of 100,000, next to London with 675,000. Southampton took some of the Cornish fish and also that from the Dorset ports. Some, too, was exported to Gascony, whence salt was imported. Bristol merchants also handled most of the fish trade of Ireland. *The Libelle* [little book] *of Englyshe Polyce*, written in 1436, probably by Adam de Moleyns, afterwards Bishop of Chichester and Keeper of the Privy Seal (murdered 1450), quoted by Hakluyt,[9] says of Ireland:

> Commodities of it I will entitle,
> Hides, and fish, Salmon, Hake, Herringe . . .

In the same connexion there was a saying:

> Heryng of Slegothe [Sligo?] and Salmon of Banne
> He is made in Brystowe many a ryche man.

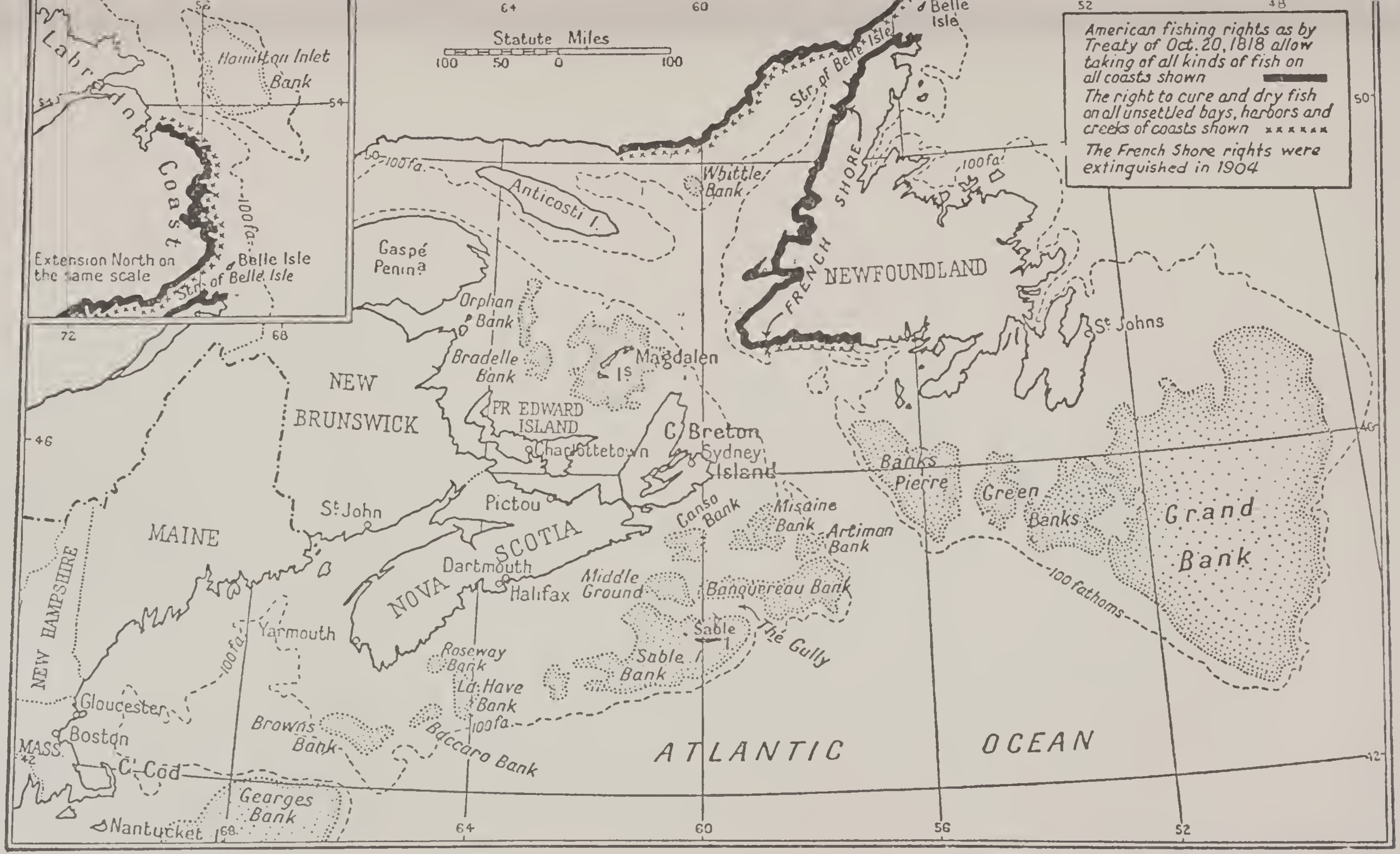
But as English cloth production and her population expanded, home-produced fish was insufficient for her needs and fishermen and merchants explored further afield. During the fourteenth century, stockfish imports from the Netherlands and Norway increased. Also, there are records of fishermen from Cromer and Blakeney fishing off the coasts of Denmark and Norway as far north as 'Finmark', i.e. presumably the Lofoten Islands, which are still famed for their cod.

NORWAY

The Norwegian fishermen preserved their cod by drying alone without salt, as stockfish. The climate of northern Norway with its cold, dry spring weather with plenty of sun and also wind, was eminently suited to the preparation of such a dried product which would have decomposed excessively in the process at higher temperatures and humidities.

As early as the twelfth and thirteenth centuries German merchants were visiting Bergen in the summer and returning home in the winter.[10] Finally they settled there and about 1350 the Hanseatic League established its office there. The two chief commodities for which they traded were stockfish of various types from the Lofoten Islands (i.e., 'lob' made from large cod, *rundfisch*, i.e., round fish, and *rotscher*, or split fish) and cod-liver oil. The latter was obtained by allowing the livers to rot, as described simply and graphically by a visitor to Iceland in 1563: 'Having taken them they plucke out the bones, and lay up their bowels, and make Fat or Oyle of them.' These dark-coloured, evil-smelling oils, known as train-oils from a corruption of the old German word, *träne* (a tear), according to Drummond, were used extensively throughout Europe for illumination (*see* p. 171) and for dressing leather. The lamps consisted of black iron trays, one above another, with a wick hanging over each corner; they must have smoked badly and smelt abominable. Bergen and Hamburg became the principal outlets for the oil produced in the northern countries, hence 'Bergenthran'. Newfoundland later became an important producer (*see* p.129), and although the blubber of seals and whales was also used for train oil, it seems that cod-liver oil preponderated.[12] The heraldic arms of the Bergen office consisted of half the German eagle and a stockfish crowned. Plates 5–9, illustrating the stockfish trade, were obtained in the Hanseatic Museum in Bergen.

At the end of the fifteenth century, the Norwegians began using the method of salting in barrels, as developed by the Dutch for herrings. The hold of the Germans was broken in 1559, but it was only in 1764 that the last Hanseatic counting house was sold at Bergen. It was not until the seventeenth century that the Norwegians learnt from English merchants how to salt cod for subsequent drying.[13]



By courtesy of the Carnegie Endowment for International Peace.

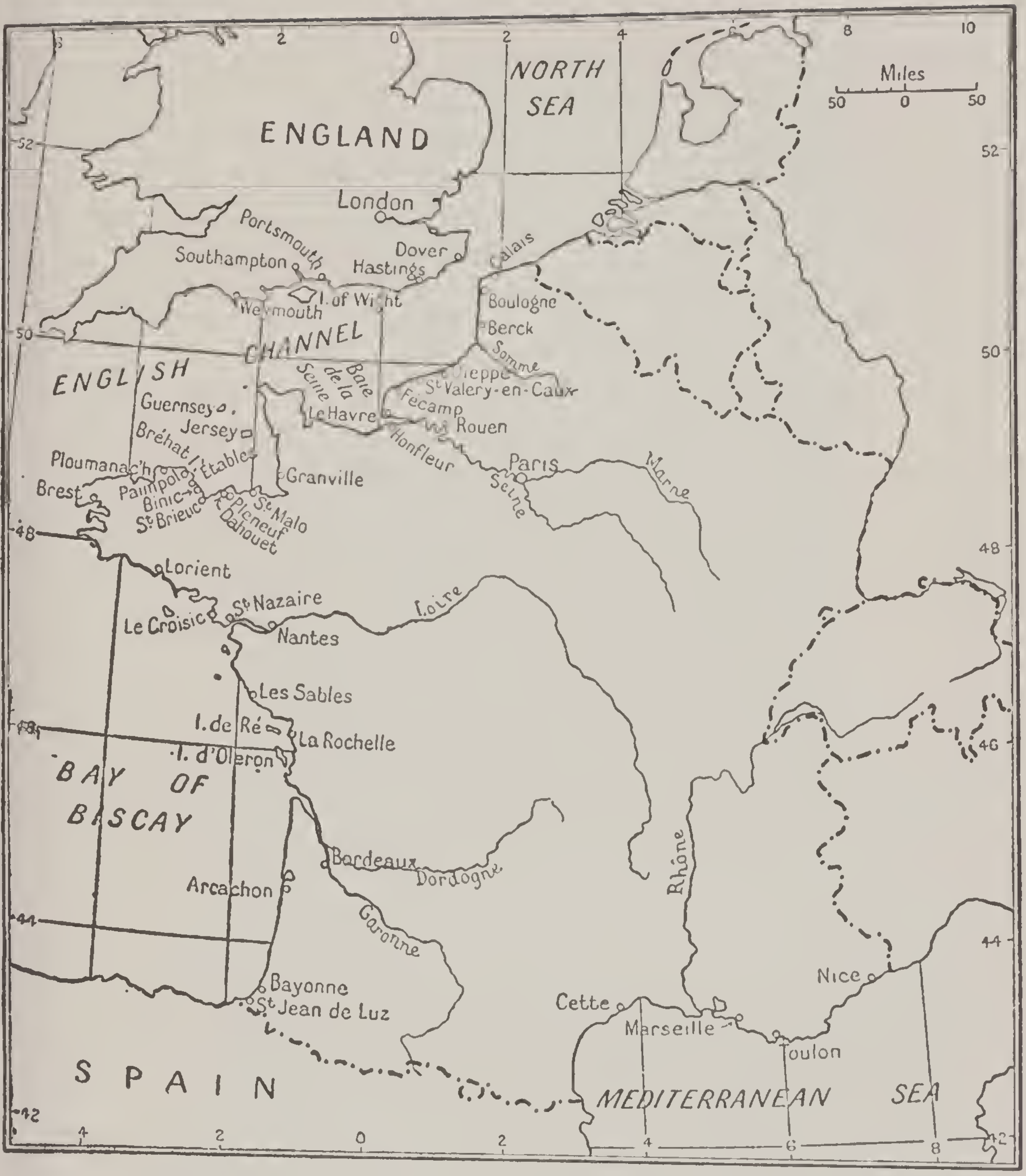
FIG. 6.—Western Atlantic Fishery Grounds. *From* The Cod Fisheries *by H. A. Innis.*

ICELAND

Iceland had been reached by the Irish in early Christian days and later by Norse rovers, who also settled in Greenland and knew about America.[14] The population of these Norse settlements subsisted practically entirely on the flesh of the fish and mammals taken from the surrounding seas. Dried fish, most likely to have been dried cod, is mentioned in the Icelandic saga of Einar Sokkason from the early twelfth century, describing the depredations of a party of marauding Norwegians led by one Ketil.[15]

Seamen from the English east coast ports, guided by birds, first reached Iceland in the twelfth century. In the reign of Edward I (1272–1307) the Suffolk port of Dunwich, now beneath the waves as a result of coastal erosion, sent twenty ships annually to the Iceland and North Sea fishing, according to its historian, Gardner, writing however, long afterwards in 1754. Hakluyt records that men from Lynn kept up a trade there until 1360 at least.[9] But most of this seems to have been forgotten by the fifteenth century.

In the twelfth century, fishing vessels were, in fact, large rowing boats with fourteen to twenty-six oars and a single square sail which was set when the wind was favourable. The rudder was introduced about 1300 and, by the fifteenth century, ships were being vastly improved so that they could sail nearer the wind; the use of the lodestone was known, and the pivoted compass was beginning to come in. Iceland, which became economically isolated with the decline of Scandinavian sea power, agreed to union with Norway in 1262. When the Hanseatics drove the Norwegians from the Baltic trade, trade with Iceland was stimulated, and it was complained that the vast cargoes of fish shipped from her harbours left insufficient for her own consumption. Then when the Hansa challenged the monopoly of Bergen and undermined Norwegian trade with her dependencies, Iceland was completely cut off and welcomed the first English ship, probably from Cromer, in 1412. In 1413 there were three or more English fishing 'doggers' off the Vestmann Islands and, despite interference and protest by the Danish government, merchant trade followed. In 1415, six merchantmen arrived and the Danish governor took advantage of them



By courtesy of the Carnegie Endowment for International Peace.

FIG. 7.—French Fishing Ports. *From* The Cod Fisheries *by H. A. Innis.*

to come to England 'with 50 lasts of dried fish and silver of great price' to pay a vow to St. Thomas at Canterbury. A few years later unruly English sailors kidnapped the governor and took him to England, not, it seems, without the encouragement of the Icelanders themselves.

In 1420, an edict in Iceland determined the value of English wares in terms of fish, e.g. three fish = one pair of women's shoes, and fifteen fish = one firkin of honey, fish being defined as '*piscis durus vocatus* stockfyssh'. Bristol is mentioned in connexion with the Iceland fishing in 1425 and Scarborough in 1436. In the latter year, the author of the *Libelle* could write:

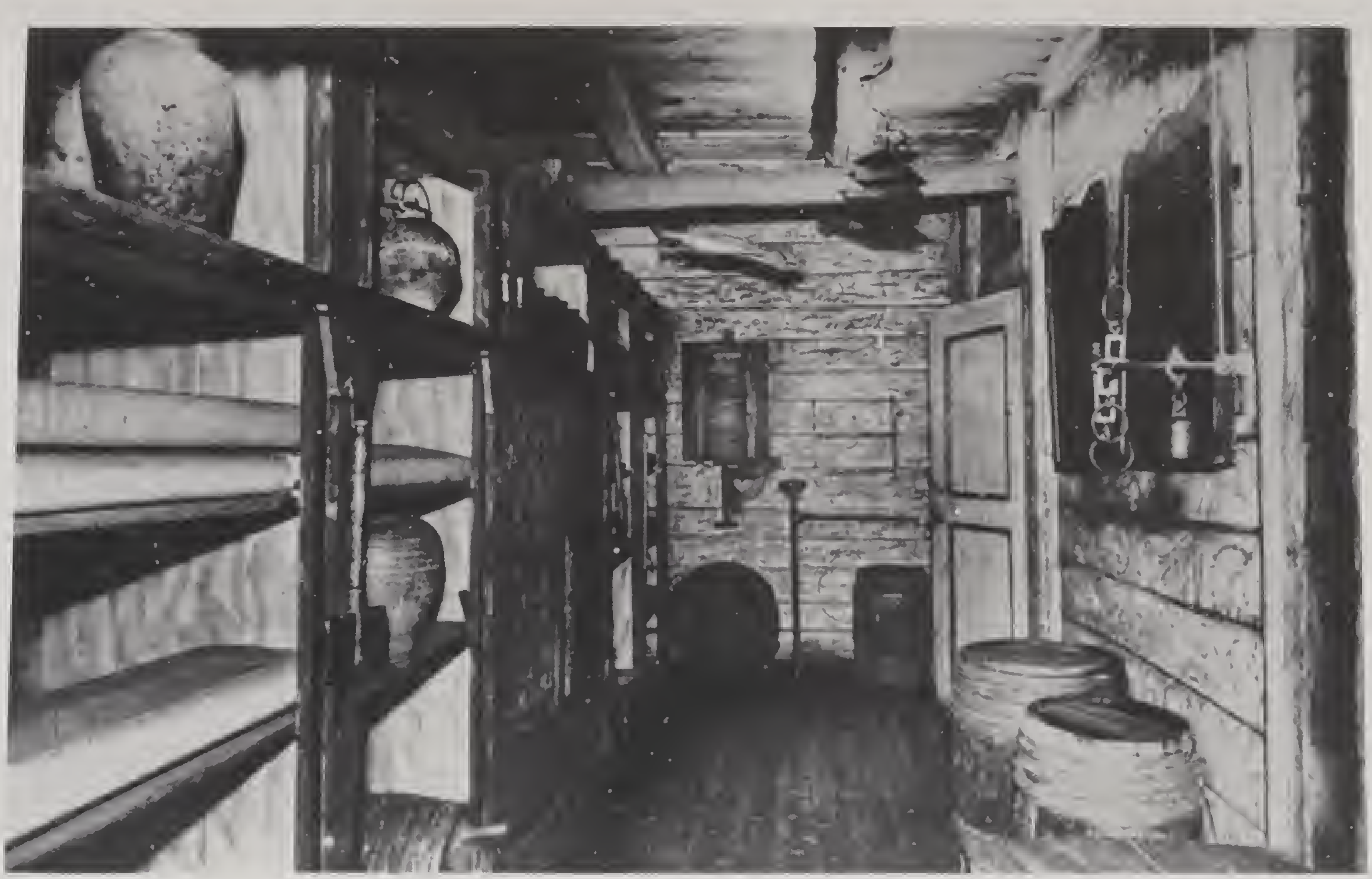
Of Yseland to wryte is lytile nede
Save of Stokfische; yet for sothe in dede
Out of Brystowe and costis many one
Men have practised by nedle and by stone
Thiderwardes wythine a lytel whylle;
Wijthine xij yeres, and wythoute parille
Gone and comen, as men were wonte of olde
Of Scarborough, unto the costes colde.

A few years later in response to protests from Denmark, a treaty was signed with England prohibiting trade with Iceland, although an exception was made for Thomas Canyng, Mayor of Bristol, on the grounds that he had rendered great service to the Icelanders.

Despite various Danish attempts at suppression, numerous ports took part in this trade, including chiefly Bristol, Lynn, Scarborough, Boston, and Cromer. Even a tiny Suffolk port like Walberswick, now derelict and silted up, had at one time thirteen 'barks' trading to Iceland, Faroes, and the northern seas.

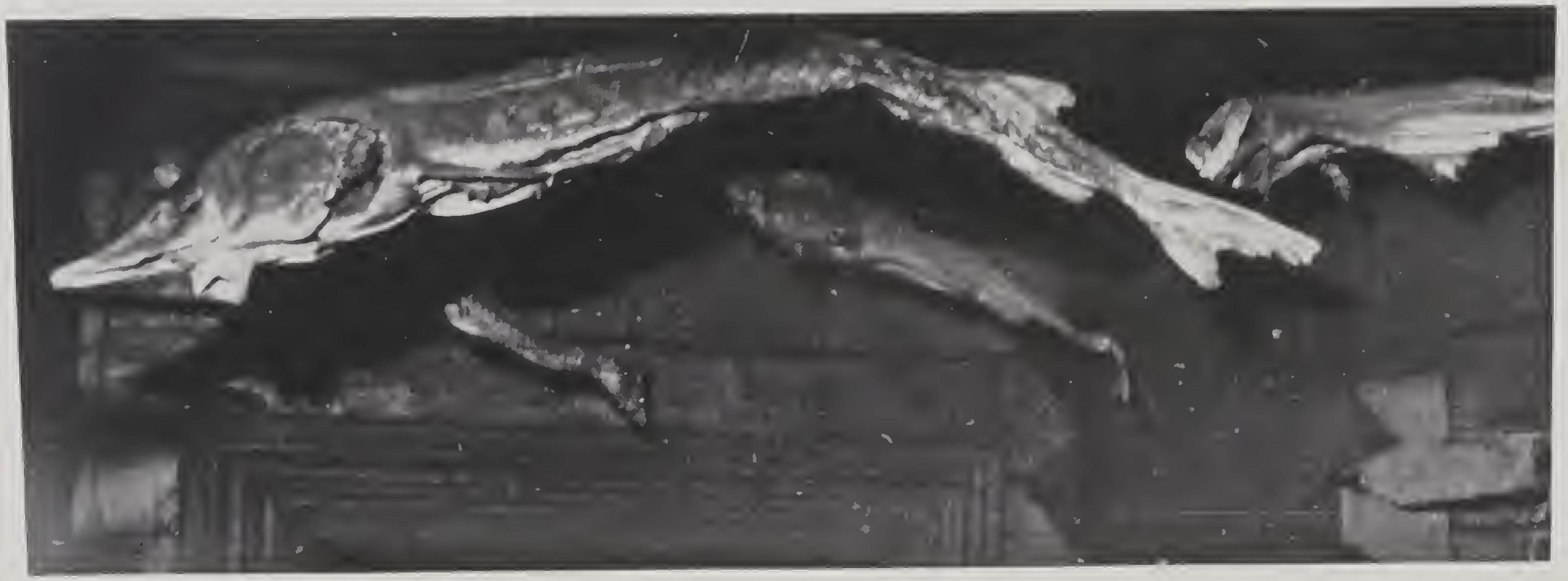
The prosperity of Hull in the sixteenth century was attributed by Camden largely to 'their trade of Iseland-fish, dry'd and harden'd, term'd by them Stockfish; which turns to great gain, and has strangely enrich'd the town.'

English 'doggers', or two-masted ketches, which were flourishing in the time of Edward III, were superior to the Icelanders' ships and could fish a greater distance from the shore, using long lines with many hooks, thus, it was complained—



By courtesy of the Hanseatic Museum, Bergen.

PLATE 5.—Reproduction of Hanseatic Merchants' Storeroom in Hanseatic Museum, Bergen. Note stockfish as mascot, cod liver oil lamp, steelyard, tally board, storage jars, etc.



By courtesy of the Hanseatic Museum, Bergen, and the Controller, H.M. Stationery Office. Crown copyright reserved.

Plate 6.—Stockfish (including a sturgeon) in the Hanseatic Museum, Bergen

reminiscent of inshore fishermen to-day—preventing the approach of fish nearer the shore, so that the Icelanders waited in vain with their little boats. One dogger could carry fifteen lasts of fish (about thirty tons) and five to ten men along with a summer's provisions and the salt, with which they salted the fish as fishing proceeded. The voyage started in February or March and took only a week with a favourable wind. By the end of the summer, mariners might hope to return with all their original cargo of salt absorbed into merchandise ready for sale at home in October and November, when it would be kept for Lent. 'Ling' would keep for two years if it were put into thick straw and covered with mats, 'close and dry'.

As a result of the political disturbances, and the Wars of the Roses in the second half of the fifteenth century, Britain lost supremacy in the Iceland trade, although not in the fisheries. The Iceland voyage became a reward for political services, e.g. by Edward IV after the Battle of Towton in 1461. By the fourteen-eighties the Hanseatics were competing with the English even in fetching fish from Iceland to London. In 1491, however, the fishing was still being actively prosecuted, and apparently unruly English fishermen were still causing trouble, because Henry VII writes to 'John Ver, Erle of Oxynford, Gret Chambyrleyn and Admirale of Yngland' on 6th April 'in that ye desyer all the dogers of thos partes schuld have our licens to departe in the viage towardes Islond, as they have ben accustommyd to do yerly in tyme passyd . . . owr fully interly beloovyd cousyn the Kyng of Demarke hath . . . complaynyd . . . that . . . our subjectes . . . stelle, robbe, and exstorte his subjectes there ageynse ryght and conciens.'

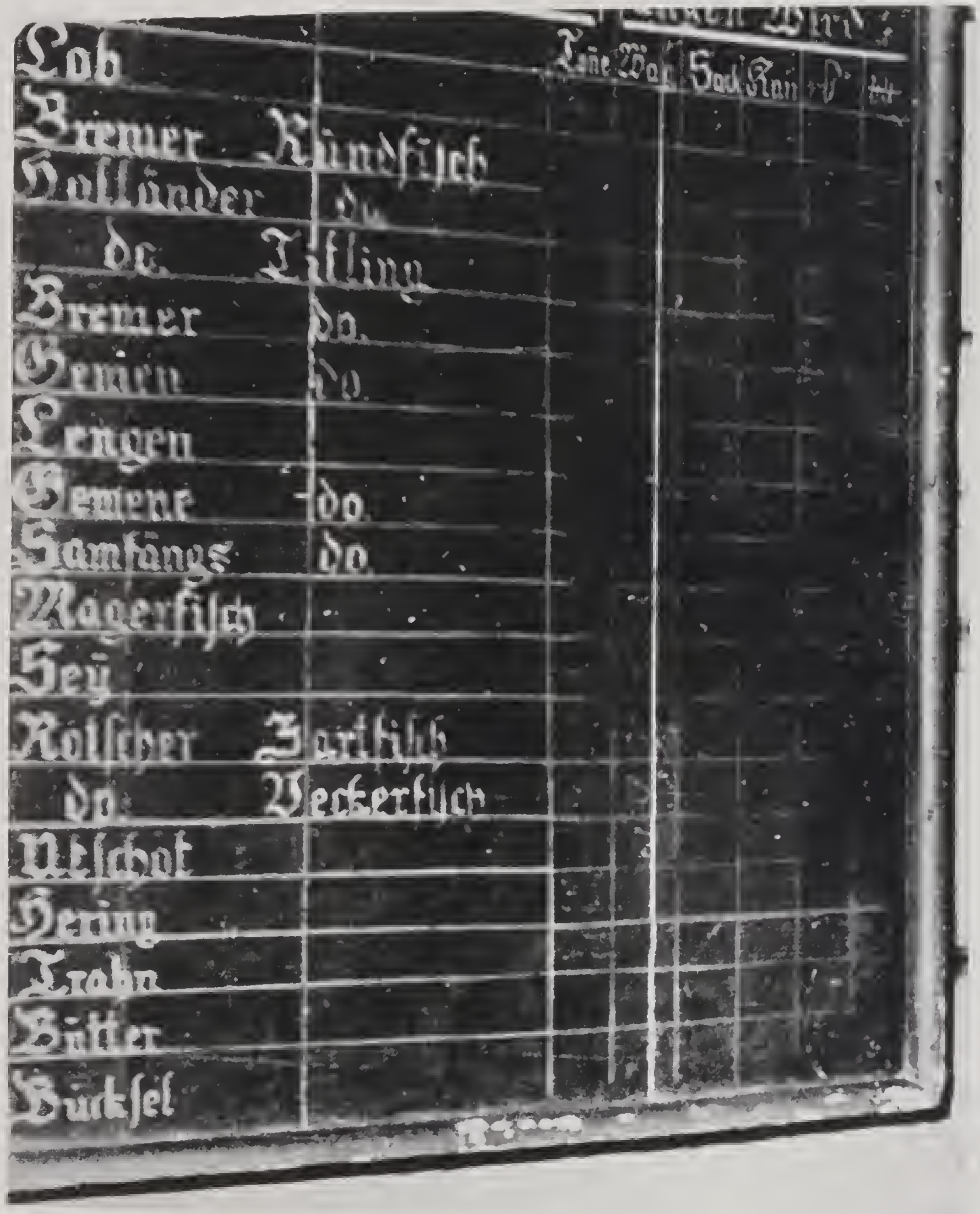
The waters between Britain and Iceland were also fished, particularly round about the Shetland Islands, which were under Danish control until they were put in pawn to Scotland in lieu of a dowry for a royal marriage in 1469, and the Faroe Islands, which remained Danish.

In 1532, the London fishmongers stated that 'seven score and odd ships went to the Iceland fishing, about 50 crayers [small fish-trading boats] went to Shetland and about 220 from Scarborough.' Another statement of the reign of Henry VIII says that sixty-nine vessels went to Shetland for ling. In 1545 a certain James of Dunwich took 43*s.* worth of 'reyd heyrryng' as supplies for an Iceland trip. In 1552 or 1553, the numbers recorded were much smaller: forty-three going to Iceland, ten to Shetland, and eighty to the North Sea. The fishing continued to decline. In 1593 Dunwich and Walberswick sent only two vessels each and Southwold four to the Iceland fishing, and by 1665 Southwold alone sent ships, three in number. The fishing was fairly widely dispersed round our coasts. Thus, in 1594, Camden writes of the Isle of Thanet and Broadstairs that a few years earlier several ships used to go regularly to the Iceland cod fishery, but that at the time of his writing it was no longer lucrative. At the beginning of the seventeenth century, Fife fishermen were fishing in the waters off Shetland and the Faroes. The vessels fishing the northern waters were larger than those fishing the Dogger Bank. The Dutch were also particularly active in Shetland waters (*see* p. 157). The trade with Iceland continued and in 1676 dried Iceland fish, presumably stockfish, was still one of the staple products of the trade of Hull.

THE DISCOVERY OF NEWFOUNDLAND

It was the cod fisheries of the north-west Atlantic, particularly Newfoundland, which soon dominated the scene and continued to do so for more than four hundred years until the present phase of Arctic trawling got under way. The history of this fishery, recently written by Professor Innis, is full of interest for the light it throws on fish technology as a factor influencing the history of nations. It is from his work that most of the following account, including the quotations, is derived.

Newfoundland was discovered in 1497, by Cabot the Venetian. His companions were practically all English and from Bristol. It was reported soon after their return 'that the sea there is swarming with fish . . . [and] . . . that they could bring so many fish that this Kingdom would have no further need of Iceland' with its hampering regulations of the King of Denmark. Bristol merchants went with Cabot on his second voyage in 1498. An account reproduced by Hakluyt says: 'It yieldeth plentie of fish and those very great, as seals, and those which commonly we call salmon: there are soles also above a yard in length; but specially there is a great abundance of that kinde of fish (much like unto tunnies) which the savages call *baccalaos*'



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Lob							
Bremer	Rundfiſch						
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do.	Titling						
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Gemeine	do.						
Samfängs	do.						
Magerfiſch							
Sey							
Rotſcher	Zartfiſch						
do.	Beckerfiſch						
Utſchot							
Hering							
Trahn							
Butter							
Bückſel							

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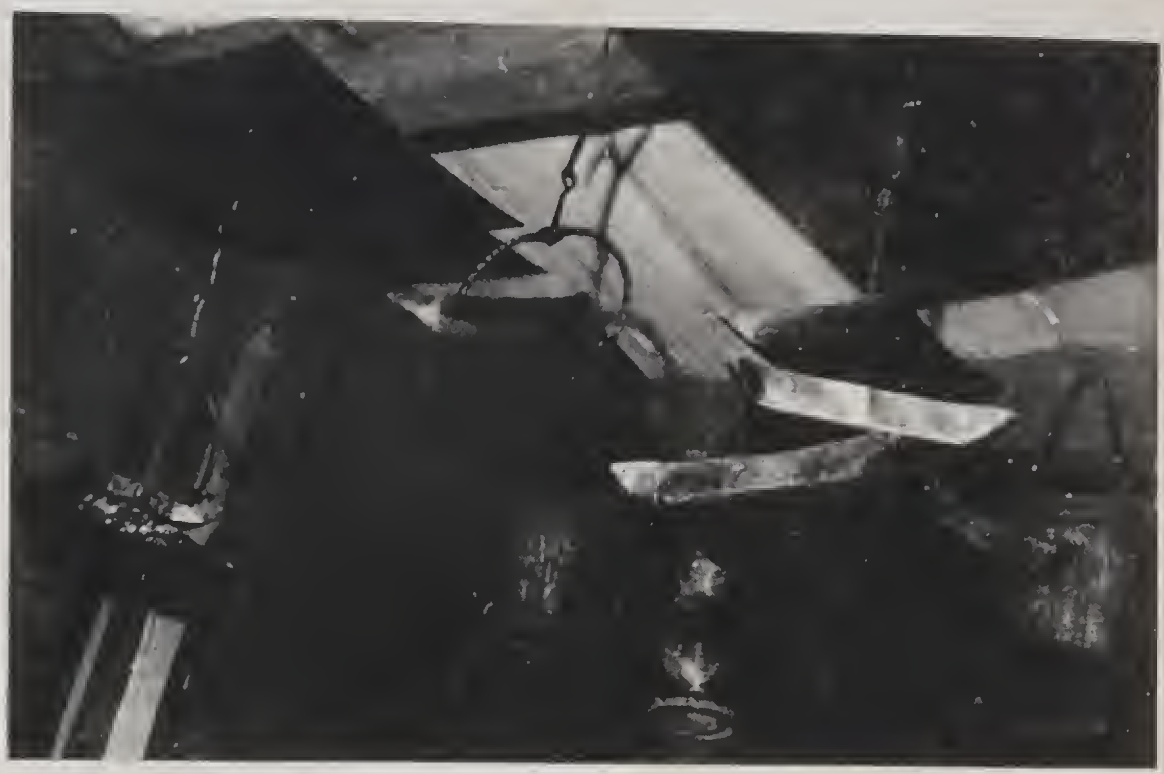
PLATE 7.—Tally-board in the Hanseatic Museum, Bergen.

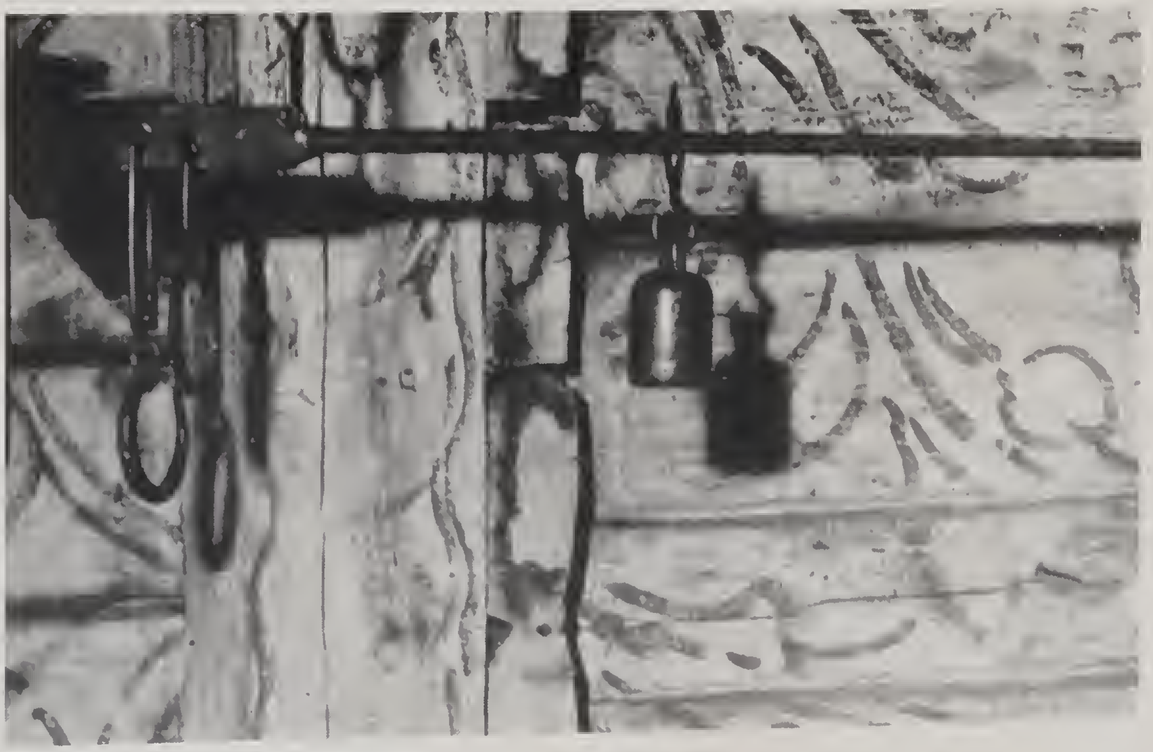


(*a*)

PLATE 8.—(*a*) Cod-liver oil lamps in the Hanseatic Museum, Bergen. Note leathern fire buckets at hand. (*b*) Replica of Hanseatic steelyard in Hanseatic Museum. The unit of weight was the 'wagen', equivalent to about 18 kg. or 40 lb.

By courtesy of the Hanseatic Museum, Bergen, and the Controller, H.M. Stationery Office. Crown copyright reserved.

(*b*)



(cod, surely). Bristol ships soon started exploiting the area. They sailed in the spring to Portugal for salt, thence to Newfoundland for fish, then back to Portugal where the fish were sold and whence cargoes of wine, oil and salt were brought back to England. But despite government encouragement, England still continued to depend largely on Iceland in the first half of the sixteenth century. Thus, although 149 vessels all from east coast ports—including eight from London—were engaged at Newfoundland in 1528, the number had fallen to eighty-five by 1533.

French vessels first arrived in 1504 and Portuguese in 1506, and both countries were soon fishing there in strength. France soon outstripped Portugal. In 1509 Norman and Breton vessels were there in force, and in 1510 'Newland' (*Terreneuve*) fish was being sold in Rouen. In 1517 it was said:

> Nowe frenchemen and others have founden the trade,
> That yerely of fyshe there they lade,
> About an C [hundred] sayle.

In 1522 the war with France began, and during 1523 the English captured a Rouen ship manned by eleven men and loaded with 9,000 fish. A document of 1531 refers to the plundering of a Breton vessel with a cargo of salted fish from the 'new founde island' which took refuge in Ramsgate in a storm. Twenty-five such ships were captured in 1547.

As in the Hanseatic stockfishery, cod liver oil played an important part as a by-product. Although some of the 'trayne oyle' from Newfoundland derived from seals and whales, by the same process of rotting, most of it came from cod livers; it was used chiefly for the treatment of leather. In 1523 a contractor, in return for fitting out a ship for a voyage to Newfoundland, was entitled to a share of 'la tierce partie de la pesche, huilles, gaings et prouffiets [gains and profits] qu'ils ont faict en leur voiaige de la Terre Newfve, selon le cours de la mer [after the fashion of the sea].' Another third of the proceeds went to the owner and one-third to the men. In 1533, at La Rochelle, a man promises to deliver 2,000 'moulles parées . . . bonnes et merchands' (i.e. dressed cod fish, prime and merchantable).

An Act of Henry VIII in 1542 that gave free entry for fish imported from Ireland, Scotland, Orkney, Shetland, Iceland,

and Newfoundland, shows that the new grounds were contributing significantly to Britain's larder by the middle of the sixteenth century. However, the French preponderated in the exploitation of the new-found fishing grounds. Of 128 vessels sailing to Newfoundland prior to 1550, 11 were English, 12 Portuguese, 3 joint English and Portuguese and 9 Spanish, whilst 71 were from La Rochelle and 22 from other French ports, such as Bayonne and St. Jean de Luz.

Fishermen from the Spanish Basque ports started fishing Newfoundland about 1545, following a decline in the fishing off the south-west of Ireland. In 1564–5 it was stated that 'There goeth out of Fraunce commonly five hundreth saile of shippes yearly in Marche to Neuvefound lande, to fish for Newlande fish and comes home again in August.'

In order to encourage the British fishery, one of the several Acts of Elizabeth passed in 1580–1 with a view to 'the better maintenance and encrease of the navy', banned imports of foreign cured fish by Englishmen, but exempted fish from Iceland, Shetlands, and Newfoundland. This was repealed in an Act of 1597–8 of which the preamble, already quoted (p 33), stated that 'the natural subjects of this realm not being able to furnish the tenth part of the same with salted fish of their own taking, the chief provisioning and victualling thereof with fish and herrings hath ever since been in the power and disposition of aliens and strangers, who thereby have enriched themselves, greatly increased their navigation and extremely enhanced the prices of that victual.'

NORTHERN NORWAY AND RUSSIA

The 'discovery' of the White Sea by the English followed next, although Dutch traders were there first. Reading Hakluyt's account makes it clear that Tudor exploration had two principal practical objectives; namely, markets for Britain's chief export commodity, wool; and the import of dried salted fish, which came not far behind in importance. The log of Sir Hugh Willoughby's own ship, which perished in Lapland in 1553, noted of the Lofotens 'there was no merchandise there, but onely dried fish, and traine oyle.' In the articles of the second voyage in 1555 'it is decreed that when the ships shall arrive [in Northern Norway] . . . they may bargaine with . . .

the inhabitants . . . along the coast for a large quantity of fish drie or wet killed by the naturals or to be taken by our men at a price reasonable . . . for cloth, meal, salt or beere . . . Note diligently what be the best wares for those parts and howe the fishe falleth on the coast, and by what meane it is to be bought at the most advantage, what kinds and diversities of sortes in fishes be, and whether it will keepe better in bulke piled, or in caske.' An expedition of 1580 to Nova Zembla was instructed that 'if there be no people at all there to be found, you shall specially note what plentie of whales and of other fish is to be found there, to the end we may turn our newe found land fishing or Island fishing or our whale fishing that way.'

On the third voyage in 1556 they are 'to use hookes and other engines as they have aboard to take fish.' In 1557, fifteen leagues west of the North Cape of Norway 'we fished being becalmed and tooke great plenty of cods. The inhabitants live only by fishing and make much stockfish, which they dry with frost' (natural freeze drying?).

The other ship of Willoughby's expedition, under Richard Chancellor, reached Russia and found there a thriving trade in salt fish and corn. 'You shall meete in a morning seven or eight hundred sleds coming or going . . . between Mosco and Jeraslave . . . [some] that at least dwell a thousand miles off.'* They were presented on the Kola River with 'foure dryed pikes'. In 1557 they encountered the Dutch buying stockfish from the Karelians, but found both the latter and the 'Emperor of Russia his deputie' anxious to conclude some sort of agreement to stimulate competition with the Dutch for stockfish and 'salmons salted and dried in the smoke.'

GREENLAND

Frobisher, searching for the North-West Passage to Cathay, noted off Greenland in 1577 that 'this coast seemeth to have good fishing, for we lying becalmed let fall a hook without any bayte and presently caught a great fish called a Hollibut, who served the whole companie for a dayes meate, and it is a dangerous meate for surfeiting.' The Greenland coast is still famous for its halibut. Landing in 1578 on the southernmost tip, when 'the inhabitants left their tents in haste . . . (we) found . . . red herrings, whereby it appeareth that they have trade with some civile people or else are indede themselves . . . workemen.' In Baffin Land, the Esquimaux lived on fish either raw or parboiled in a little water, or its own blood.

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* Gogol, writing of 'Sorichinski Fair' in 1800, mentions salt and fish as the two chief commodities.

SUPREMACY OF NEWFOUNDLAND

However, in spite of these searches in alternative directions, it was Newfoundland and the surrounding seas which soon became by far the most prolific centre for fish production for the Western World. Already by the last quarter of the sixteenth century, this fishery was important.

Two Chester merchants in 1580 purchased '34,000 Newland fish merchantable at 10*s*. the 100 . . . also four tonnes traine at £12 per ton.' As a result of the war with Spain prices rose, and at Chester in 1586, 20,000 Newfoundland fish were purchased at 20*s*. per hundred for the army in Ireland. After the victory over the Armada, the English Newfoundland fishing increased, accelerated by Denmark's enforcement in 1580 of payment of licence fees for Iceland fishery. There were one hundred sail there in 1594, and the English fishery industry shifted its main activities from east to west coast ports. The ascendancy of Holland in the North Sea after the declaration of independence of Spain in 1581 made the west coast ports' attention to Newfoundland all the more important.

Plymouth alone had fifty ships at Newfoundland in 1595. In 1597, Dutch, Irish and French ships visited Plymouth in September to purchase fish. Other south and south-west ports, such as Weymouth, Poole and Southampton also took part. Salt fish was exported to the Levant, the Canary Isles and Madeira.

Sir Humphrey Gilbert, who occupied Newfoundland in 1583, seized two French vessels engaged in the Newfoundland trade, one loaded with wines and the other with salt. The rise of the English fishery forced the French away from the coasts of Newfoundland where they 'found a fishing land 50 leagues off to sea . . . and called it the Bank, where commonly they make two voyages yearly without going ashore to dry their fish, and therefore it is called wet fish'; it was also larger than coast fish. Other areas were also found to be full of fish, north of Cape Breton, the Labrador coast explored by Davis in 1586, Ascension Island (Anticosti), etc.

METHODS OF SALTING AND DRYING

The two main methods of preserving fish in the Newfoundland region were salting alone and barrelling, known as the green fishery, or the core fishery, most practised by the French; and salting followed by drying, as developed for the Spanish, Portuguese, and Mediterranean market. The requirements for salting and drying fish to a large extent determined the subsequent history of the countries bordering the north-west Atlantic. Thus Britain, unlike France and Portugal, did not make solar salt (i.e. by evaporation of brine in the open). They therefore went in for the dry fishery, which necessitated settlements where climatic conditions were suitable, for example the east coast of Newfoundland and later New England, where cool winters and abundant sunshine permitted even the large cod caught in the Gulf of Maine to be dried successfully.

The larger fish taken on the Banks by the French could not be dried, and thus the careful salting of these was obligatory. The French ships were of about one hundred tons burden, with accommodation for a crew of fifteen to eighteen and provisions for six months. They fished by handlines and caught daily anything between 25 and 200 fish, sometimes even 350 to 400 fish. Practice no doubt varied, but according to one account, boys took the fish to the men who dressed them. The fish were placed on narrow tables where one man cut off the head and threw it into the sea, a second cut open the bellies and eviscerated them, and a third cut out the backbone, after which they were passed to the salter. On the bottom of the hold fish were arranged head by tail and covered with a layer of salt; successive layers were laid above it and similarly salted until the end of the day. After the fish had been left three or four days and the brine had been drained away, the surplus salt was removed and new layers were put down and covered with new salt as before. This last treatment was regarded as final and the fish were ready to be taken to France.

On the approach of Lent with its obligations to refrain from eating meat in Catholic countries, even ships with as little as half or two-thirds of a cargo set out with their fish for the Paris market, for the first arrivals got the best prices for the new season's cod. Very early arrivals could return for a second voyage and still be in time for the Lenten sale. The Bank fishery was usually completed by the end of May. Sometimes a third trip was made to coast areas. At least three-quarters and sometimes practically all the catch was for consumption in Paris, which was a town many times larger than London at that time. A ship of 100 tons would bring back from 20,000 to 25,000 fish.

The Portuguese in 1578 were fishing with 'not lightly above 50 sale'. They 'make all wet [i.e. green fish] and do drie it when they come home', about 300 tons in all. In the same year there were 'above 100 sail of Spaniards that come to take cod . . . besides 20 or 30 more that come from Biskaie to kill whale for traine.'

The English when they first took up the Newfoundland fishing seriously at the end of the sixteenth century 'had not the use of barrelling up of cod, and if it be not barrelled it is not vendible in France, neither can they make haberdine for if they could it would be well sold in Spaine and Portugal.' However, what they had learnt from their experience with Iceland stockfish was applied to Newfoundland's small fish, with scanty supplies of salt to produce a hard, dry cure, meeting the demands of warmer countries. The dry fishery used only about half as much salt, which they obtained in strictly limited quantities from the Portuguese ships, who found it difficult to carry much more than was required for their own green fishery together with their own provisions.

The English hoped to find salt mines. The writer of a letter dilating on the possibilities of the fishery about 1600 remarks that 'the climate doth give great hope that though there were none actually growing, yet it might as well be made there by art, as it is both at Rochel and Bayon or elsewhere.' As a result, the English fishery concentrated in regions and times of the year suitable for 'light-salting', where trade could be carried on with the Portuguese. Sir Humphrey Gilbert had granted on Newfoundland 'grounds convenient to dresse and to drie their fish'. In early August the weather was 'so hote this time of yeare except the very fish which is laid out to be dryed by the sun be every day turned it cannot possibly be preserved from burning.' 'Four and twentie persons' were therefore employed in 'turning of drie fish'.

As Spain declined at the end of the sixteenth century, Britain and France captured her market. At first, West Country fishermen went to Newfoundland, cured the fish and brought it home for consumption. Later it began to be exported from England and later still London ships went to Newfoundland, purchased fish and carried it to the Mediterranean in a triangular trade. One of the first attempts at trading—which in actual fact turned out unsuccessfully—was that of the London & Bristol Co., which in 1610 sent out John Guy to purchase cod oil, if obtainable at £8 per ton, to load salt 'for our use to be used in fishing, or to be sold to ye fishermen' and he was asked 'if you can buy there 60,000 of good dry fish reasonable.'

Ships left England for Newfoundland every year about the end of April and returned in September. The fishing was very prolific. They 'do not onely catch as many fish as will lade their shippes, but also as many as will lade vessels of greater burthens that in the sumer come hither from England and other parts to buy up the same and purposely to transport it for Spaine, Italy and other countries.' These transports were called 'sack ships' (1650) probably from the fact that they carried white wines from Spain and the Canaries as return cargoes, as well as salt, oil and gold bullion. The greater part of the salt and much of the oil and wine was re-exported to Newfoundland, together with huge quantities of sail-cloth, cordage, nets (made at Topsham, on the Exe, then an important port, now quite decayed) linens and provisions. Some ships returned direct from Newfoundland with great quantities of train oil from cod livers and, in smaller quantities, cured fish and rum.

In the early part of the seventeenth century, English pirates were thriving on the Newfoundland trade. A struggle developed, too, between the trading and carrying interests and those of the West Country fishermen which was a feature of Newfoundland affairs for over 200 years. The shore interests complained that 'very large stones used to press dry fish' to keep them flat on the ship were thrown overboard into the harbour when the ships left for home 'thus spoiling the anchorage and endangering the ships and cables . . . the harbour of Renewse was in danger of being ruined.' Such stones were ordered to be carried ashore.

The hostility between West Country fishermen and the settlers (planters) who based their industry more on shore, is reflected in many ordinances, including one in 1653 to the effect that 'no planter be permitted to . . . keep any pigs or other cattle upon or near the ground where fish is saved or dried.'

In 1615 there were 250 sail fishing, employing 5,000 persons. 'Now everyone of these ships, so neare as I could ghesse had about 120,000 fish and 5 tun of traine oyle (selling at £12 per ton) so that the totall amounted in money to 120,000 pound.' 'The fish and train in one harbour called Saint Johns is yearly in the summer worth 17 or 18 thousand pounds.'

In a typical fishing project of 1622, it was estimated that with a ship of 100 tons and eight three-men fishing vessels, the catch would be 200,000 cod weighing 2,220 kentalls (or quintals, probably from Latin *centum*, meaning 100 lb. or a hundredweight) worth 12*s.* to 16*s.* per quintal or £1,320 to £1,760; also 10,000 large green fish (too large to dry satisfactorily) sold in Newfoundland for £5 per 1,000, in England for twice that; and 12 tons of oil which could be sold in Newfoundland for £10 per ton or in England for £18 to £20. A dried fish, therefore, weighed on the average about 1¼ lb., which would correspond to between 3 and 4 lb. fish before heading and cleaning, etc. These are rather small fish. A fish with its oil was worth about 1*d.*

The New England coast was explored in 1602–3, with the discovery of 'cod which are better than those of Newfoundland and with all we saw good rockie ground fit to drie them upon'. 'Only it is too thick to dry and therefore not to be vended in the straights or the southermost part of Spain.' The largest fish were therefore made into 'corefish' (i.e. green fish) which compared favourably with the 'sillie lean skinny poore John and cod fish' of Newfoundland.

'The sole purpose of the first' settlers in New Hampshire was not escape from religious persecution, but 'to acquire wealth by fishing and trading.'[16] Thus, in 1623, it was merchants from Bristol, Exeter, Dorchester, Shrewsbury, and Plymouth and other places in the West of England, who formed an association under the title of 'The Company of Laconia'.

The cool drying season of the winter months facilitated the development of a winter fishery in New England. Boston became a centre for fishing and curing. A market for the poorer grades of New England dried salted cod appeared with the growth of slavery in Virginia and more tropical regions. The West Indies slaves, of whom 2,130,000 it was estimated were taken to the British colonies alone between 1680 and 1786, 'were fed for the most part on the poorest grade of cod or refuse fish.' For this market, the New England fishermen fished the off-shore banks of Nova Scotia with 60-ton schooners manned by seven men and holding 600 quintals of fish. They salted the fish down at sea, brought it ashore, washed off the salt, and then dried it, making a rather inferior product. The best grades for the European market were taken close to the coast by small boats working from settlements. Along the coast of Maine 'The fishermen take yearly . . . many hundred kentals of cod, hake, polluck, etc. which they split, salt and dry at their stages making three voyages in a year. They separate the best merchantable . . . fish . . being sound, full grown fish, and well made up; which is known when it is clear like a lanthorn horn and without spots.' This was sent to 'Lisbonne, Bilbo, Burdeaux, Marsiles, Talloon (Toulon), Rochel and Roan.' The refuse fish is such that is 'salt burnt, spotted, rotten and carelessly ordered.' This 'they put off to the Charib Islands, Barbadoes, Jamaica, etc., who feed their negroes with it.' 'A shore man washes it out of the salt and dries it upon hurdles pitcht upon stakes breast high.' Boston, about 1700, exported about 50,000 quintals of dry fish, three-quarters of which went to Bilbao. However, the quality of the dried fish produced in New England in the seventeenth century was regarded as inferior to that of Newfoundland. It was claimed that the milder salt used in Newfoundland resulted in fewer fish becoming 'salt burnt'. Another difference which was pointed out was that in Newfoundland the fish were 'worked belly up' and in New England 'belly down'. New England obtained salt chiefly from Tortuga Island, off Haiti, whereas salt for Newfoundland came from Lisbon and Biscay. In 1763, Massachusetts had 300 vessels fishing and of the produce 102,000 quintals was 'merchantable' and 138,000 'refuse'.

The French, too, in addition to their extensive home market, particularly for large fish salted green on the Banks, also dried some of this product at home, although it was saltier and not so good as the more lightly salted product dried in Newfoundland by the English. At St. Malo, fish brought back in August and

September was spread out over large areas in the vicinity of the town. However, the fishermen from Channel ports made mainly green fish and drying was mostly done in the Biscayan ports, presumably because the climate there was better.

Spain and Portugal had dropped out of the fishing by the first half of the seventeenth century. The French had secured a foothold on the coast of Newfoundland, which they had fortified and were administering as a French colony. Later they also colonized the Gaspé Peninsula and the Gulf of the St. Lawrence River, particularly Cape Breton Island, as well as Nova Scotia. Compared with New England, the drying season there was limited by the weather and ice to early spring and summer, although not so short as at Newfoundland. Where suitable gravel beaches were not available, drying was carried out on 'flakes' or hurdles 'on which one is obliged to dry the fish when there occur at the place of fishing only sand and grass.' Here the fish were smaller than those caught on the Banks and, as on the coast of Newfoundland, were brought in daily and dried on flakes after curing with relatively little salt. Considerable skill was required in deciding how much salt was required for a particular size of fish. French practice at Cape Breton in the second half of the seventeenth century was described as follows: 'The throater, headers, splitter and salter (*piqueur*, *decoleur*, *trancheur et saleur*) dress and salt the cod. A bed of cod 9 to 10 ft. long and 3 ft. high is salted one row of cod on top of the other with flesh side uppermost'. The cod was left in 'salt bulk' for five or six days, then washed in the sea to remove the salt and piled to allow the water to drain off. 'Then they heap them together. They remain there two days and after St. John's day (29th June) for one day only on account of the heat.' Next day they were spread on the beach and turned flesh up during the day and flesh down at night. After they were dried, five or six cod were piled head on tail *en mouton* for three days and nights and finally put in a large pile, sometimes of 300 quintals, and left for a month to 'sweat' before loading in the vessels. In the Gaspé, French ships were given rights in *graves, galets et vignaux* (curing beaches, landings, and drying frames) in preference to residents. This was in sharp contrast to the policy in Newfoundland. Space was allocated on the basis of three *vignaux* 40 fm. (of 5 ft.) long and 5½ ft. wide per boat with 3 ft. for a road between *vignaux*. The ships were allowed one boat per 20 tons and as the ships averaged 200 to 300 tons, an allowance per ship of at least 11,000 sq. ft. was necessary. The Normans, or those ships taking green fish as well as dry, were limited to two *vignaux* per boat. Competition for limited drying space led almost to open warfare between the French Basque ports of Bayonne and La Rochelle and the Normans from Honfleur. The Normans traded their small fish suitable for drying, with the Basques, for their large ones suitable for the Channel ports' green fish trade with Paris, at an exchange rate of two small for one large fish. Gaspé cod dried chiefly by Channel fishermen went to the Mediterranean market. The Biscayans mainly colonized Cape Breton, as the name suggests, and Nova Scotia and their dried fish went to domestic and colonial as well as foreign markets.

In 1722 it was said that the French fishery at Cape Breton could market fish in 'Spain, Portugal, etc. at least six weeks sooner than we can from Newfoundland.' A 200-ton ship had a crew of seventy men, three for each of fourteen small boats to catch the fish; five for each of two large boats to carry the fish ashore; five splitters, and one salter with twelve men to help him. Ten hogsheads of salt were used to one hundred quintals of fish. The fish were taken direct to the Mediterranean. The French salt was supposed to be 'weaker' than the Lisbon or Spanish salt used by the English 'so they [the French] use more and their fish weighs the heavier and its [the salt] being weak does not easily burne.'

The quality of English Newfoundland fish at the end of the seventeenth century apparently deteriorated. 'The fish brought to [Spain, Portugal, and Italy] from Newfoundland for some years past has been for the most part so ill cured that the consumption thereof is greatly abated and the trade is in danger of being thereby lost.' The French, by comparison it was pointed out, fished 'as they drive and split it alive which makes it very white, as does the abundance of salt they use for want of flat room to dry it and cure it upon ships deck and carry it to market.'

William Petty, one of Britain's first economic statisticians, complained in 1680 that 'our fishing for white herrings and cod was deserted for [plantation commodities] . . . We formerly supplied France, Spain, Muscovy, Portugal and Italy with great quantities of white herring, ling and cod fish which trade is now lost to the Dutch, French, etc. We have only the trade in red herrings which we retain.' Nevertheless, the total Newfoundland trade in 1700 was still 188,800 quintals, or about 35,000 tons and at St. John's, just before 1708, 'every family had a sort of wharfe before their houses to dry their fish on.' 'Since the English consume almost no dry fish in Europe they take it to Spain and Portugal and even to the Levant', which meant economic competition with France.

This rivalry was not the least of the causes of the War of the Spanish Succession. Under the provisions of the Treaty of Utrecht in 1713, the French were allowed to erect on Newfoundland, Hudson Bay, etc., only 'stages made of boards and huts necessary for fishing and drying of fish . . . it shall be allowed to the subjects of France to catch fish and to dry them on land in that part only and in no other besides that, of the said island of Newfoundland which stretches from the place called Cape Bonavista to the northern point of the said island and from there running down by the western side reaches as far as the place called Point Riche.' However, disputes continued because they were not agreed as to where Point Riche actually lay—there was 180 miles difference in the estimates[17]—with the result that fighting was common. A large number of Irish labourers was also taken over to the fisheries, who contrived to quarrel with the French just as much as the English. There is no doubt that the French used their fishing privileges for smuggling, just as St. Pierre and Miquelon were used for the same purpose much more recently, during prohibition.

The frequency of suitable drying beaches on the north shore of the Gulf of St. Lawrence made expensive 'flakes' less necessary. The French were also said to be more skilful than the English, and 'much our superiors' according to Joseph Banks, the explorer. In addition they 'have the properest kind of salt for the purpose of their own; . . . we are obliged to go to Rochelle, etc. to fetch that commodity.' For whatever reason, their 'smaller, whiter, better salted fish' sold for a higher price than ours in the Mediterranean.

In 1751 it was mentioned that 'sounds' (i.e. swim bladders) were being salted in barrels, holding 600 to 700 lb. and also cods' tongues in barrels holding 400 to 500 lb., which were sold chiefly in Burgundy and Champagne. The roes were salted and used on the coast of Brittany to attract pilchards. Oil was put into barrels of 400 to 500 lb. and used by French tanners. 'The standard cod is that which is 2 feet in length with the head off. The second is smaller called the midling; the third is least. The dealers in this commodity, however, subdivide it into seven or eight kinds; one of these is a fish in the opening of which, or in the severing the head some fault has been committed.'

The French continued to prosecute the green fishery. 'Followed more by the French than any other nation is the mud fishery' (*see* p. 120). The origin of this particular epithet is obscure. The cod caught on the Grand Banks or near Sable Island lay salted in the hold 'till it has sufficiently purged, then they shift its place and having salted it a second time, stow it for the voyage.' Another account referring to 1733 onwards, says that after splitting the fish were salted in the hold in 'beds a fathom or two square, laying layers of salt and fish alternately but never mixing fish caught on different days.' After being left until, in three to four days, the water (brine) had drained from them 'they are replaced in another part of the ship and salted again, after which they are no more meddled with.' Their practice was thus apparently unchanged after 200 years. The fish were taken by double-decked vessels of 100 to 150 tons which brought home 30,000 to 35,000 at most for fear of spoiling before being brought to France, especially those 'first caught unless salted with great care.' It was important 'to have a master who knows how to cut up the cod, one who is skilled to take the head off properly and above all a good salter on which the preserving of them and consequently the success of the voyage depends.' The best fish caught on the south part of the Banks were reserved chiefly for Paris 'where there is a great consumption of them. Those caught on the North side are commonly small and sell for much less.'

In Newfoundland, conflict continued between planters and fishermen, and the central government followed no fixed policy. Thus, in 1715, the merchants of Bideford and Poole complained that Britain was losing the value of Newfoundland fish to the New Englanders, and with it the prospects of naval supremacy.

Following bad fishing years in 1713–14, small ships were sent to the Banks in 1714 and 1715 'to catch and load and then come in, put their fish ashore to dry, and immediately out again leaving people ashore to cure it.' Although 'split and salted the same day they are taken' there were complaints about quality, chiefly because of others who 'send their ships and vessels on the banks for a month or five weeks, then bring the fish to land to cure; such fish as are caught at the beginning of the season are good, if rightly salted, but in the height of the summer and latter end of the year very bad.'

Competition was also coming from other sources. Thus by 1765 'the consume of Newfoundland dry'd cod fish called Bacallao has greatly lessened in this province [Catalina] by the fisheries of the same kind of fish that are at present carried on with success on the coast of Norway and at Knall [Kola?] in Russia.' The enormous amount of space required for drying in Newfoundland was one of the reasons which led to the migration of English fishermen to the mainland of Nova Scotia. However, production seems to have been increasing steadily all the time through this period; according to one estimate from 88,000 quintals in 1716 to 506,000 quintals in 1749 and 561,000 quintals in 1764. Another estimate of the total is 1,032,000 quintals and 5,160 tons of oil (10 per cent of production) which was stored in 806 train oil vats. In 1763, St. John's alone shipped 56,000 quintals of which Philadelphia, New York and other colonial ports, carried 16,000; and Dartmouth, Exeter, Teignmouth and London, another 21,000 quintals. Defoe in 1724 noted the Newfoundland trade of Poole, Weymouth, Dartmouth, and Saltash. About the same time, Pope in 1727 depicts the grief of Glumdalclitch, the giantess of Brobdingnag, that Swift had situated on the west coast of North America, for the loss of her Gulliver in the following conceit:

> O squander not thy grief: those tears command
> To weep upon our cod in Newfoundland.
> The plenteous pickle shall preserve the fish,
> And Europe taste thy sorrows in a dish.*

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* This may have been yet another instance of Augustan bathos. But there were others with less wit who were not ashamed to acknowledge the proper importance of the cod under the Lord of Creation. How otherwise can one account for such a paean as the following verse, now expurgated, if it is not apocryphal, of a metrical paraphrase of the Benedicite:

> 'Ye finny monsters of the deep
> Lift up your heads and shout!
> Ye cod fish from your hollows creep
> And wag your tails about!'

Between 1736 and 1738, 1,118 boats were fishing, catching 300 quintals each per vessel totalling 335,400 quintals, together with 45,000 quintals of fish caught on the Banks. Train oil at two hogsheads per 100 quintals amounted to 1,902 tons. Seal oil and whale oil only amounted to 350 tons. In addition, 1,000 tierces of salted salmon (a tierce was one-third of a pipe, or 40 gallons of English wine measure, i.e. a cask intermediate in size between a barrel and a hogshead) worth £3 per tierce, were exported to Italy and Spain. This latter export rose to 4,848 tierces in 1757.

In 1731, there were between 5,000 and 6,000 fishermen in Massachusetts alone, mostly engaged in cod fishing on the Banks. In 1741 there were 400 vessels from this state, 160 of which were from Marblehead ('Morble'ead' of J. G. Whittier's poem *Skipper Ireson's Ride*, the basic facts of which, incidentally, were disputed much later by Skipper Disco in Kipling's *Captains Courageous*).

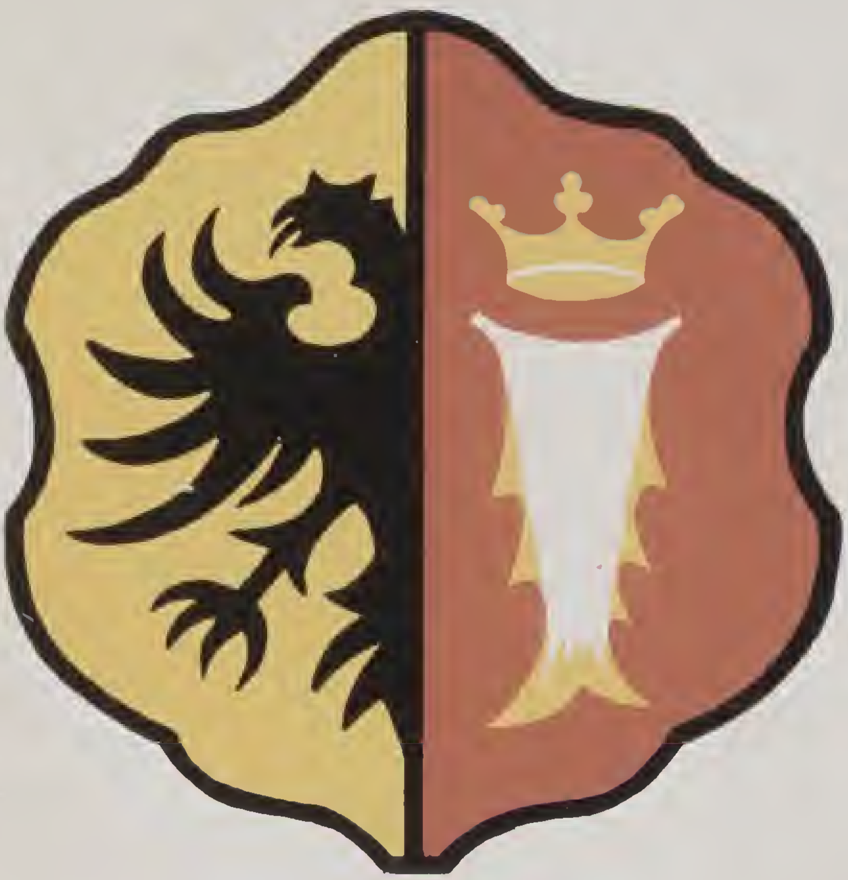
While fretting under Britain's trade restrictions with the West Indies, the New Englanders pointed out that 'our pickled fish wholly and a great part of our cod fish, are only fit for the West Indies market' so that there was no other outlet for it. After the American victory, Britain's customs regulations also irritated the Newfoundlanders and at one time there was even a possibility of them declaring their independence at the same time as the New England states. The importance of the cod fishery to the New England economy may be judged from the fact that the Massachusetts House of Representatives at Boston in 1784 passed a resolution 'to hang up the representation of a cod fish in the room where the House sit, as a memorial to the importance of the cod fishery to the welfare of this Commonwealth.'

The French still continued to be a major participant in the fishing, despite difficulties. In 1785 they still had a large home market, including a specialized one at Nice for fish not dried as much as the English product. But they were operating under considerable disadvantages. Thus they were not allowed to winter on their coast of Newfoundland, so that they were unable to maintain their flakes and buildings properly. After heading and splitting, the fish were piled in salt for fifteen to twenty days and then washed and cured in the sun. 'They use no flakes and dry their fish upon rows of shrubbery spread on the rocks.' The weather was not as good for drying near Belle Isle Strait. They had to bury surplus salt in the ground until next year.

In the Banks fishery, 'some of the French ships make two voyages . . . carrying the fish back to France to be cured. Others make one voyage to the Banks and when they complete a cargo proceed to St. Pierre . . . where they cure the fish . . . Sometimes these ships, if their cargoes are not complete, stop on their return from the coast . . . to catch fish on the Banks, which they carry in a wet or green state to France.' Costs of drying were heavy, as St. Pierre and Miquelon had no supplies of wood for stages and expensive canvas had to be used instead.

The difficulties of the French made it easier for New England, now the United States of America, to recover from their war. It was said in 1791 that 'It is . . . in the power of the Americans to make more advantage of the cod fishing than any European nations . . . We can dry it in a clearer air than the foggy shores of Newfoundland and Nova Scotia.' Between 1790 and 1810 they had 1,232 ships, of which 584 went to the Banks, and 648 to Chaleur Bay and the Labrador coast, each area producing over 500,000 quintals from approaching 100,000 hogsheads of salt. In 1829, of 2,108 vessels off Labrador, producing 1¾ million quintals and 17,500 hogsheads of oil, 60 per cent came from the United States. In 1833, New England schooners of 70 to 80 tons were making one trip to the Banks between 20th March and 20th May, one to Labrador lasting until 20th September and finally one to the Banks again in November. On the Labrador coast, part of the fish was cured, producing a softer cure owing to the fact that drying was difficult in the cooler climate, and sent direct to the Azores, Madeira, Portugal, Spain, and the Mediterranean. Green and 'refuse' fish was taken home and sorted, the poorest going to the West Indies. The oil was sent to England. The New Englanders tried curing Banks fish on land in Newfoundland using Turks Island salt until they were prevented by legislation.

After the Declaration of Independence, Nova Scotia emerged as the chief base for the British fishery. The product was not very good. It was complained at Liverpool, N.S., in August 1803 that 'Fish in general very salt and a great deal of salt is dry among them which is a waste of salt and damage to the fish . . . They prove very salt indeed so that they break to pieces many of them



By courtesy of the Hanseatic Museum, Bergen.

Plate 9.—Coat of Arms of the Hanseatic Office in Bergen.

when they have had only two days sun.' Again in November, 1811: 'It is rare to get them dry at this season. When they are brought in boats and when we get them early they are seldom made thoroughly, all which is much against the small trade with the boat fishermen'. In December, 1811: 'The shore fish are so dry and horney that we get only 8 cwt. in a common hogshead.'

Agitation in Nova Scotia against Britain's trade restrictions led to an Act passed in 1826 opening ports free of duty in the British West Indies and North America, with the exception of Newfoundland. The abolition of slavery in 1807 led to demands for better grades of fish. The steamship also speeded up transport to overseas markets. Thus in 1825, it took twenty-one to twenty-three days to go from Quebec to Halifax, and the return journey upstream even with a following wind was very tedious. The first steamship in 1831 took only nineteen days for the round trip.

The English fishery from Exeter and the south-west ports began to decline in the last quarter of the century. There were 300 ships fishing in 1792, fifty in 1817, and only 15 in 1823. Norway was a serious competitor and now supplied Barcelona almost entirely. She had first begun to export *Klippfisk* (salted cod dried on the rocks or *Klippe* from Fosna (Kristiansund) about 1700; a merchant there first sent a whole ship-load to Spain in the first half of the nineteenth century. Spanish importers thereafter began to send their own ships to Norway to load up and Portugal joined in the trade which spread to the Caribbean and South America. Stockfish was sent to Italy. By 1827, 20,000 men were employed in the Lofoten fishing, making stockfish until about the end of April, but *Klippfisk* thereafter, because the stockfish went bad before it was dry in the warmer weather.

After 1815, Newfoundland schooners started going to the Labrador coast, making two voyages loaded with dry fish back to Newfoundland during the summer. A considerable part of the second cargo came in as green or pickled fish, which was afterwards dried in Newfoundland. Italy preferred the smaller fish and Spain the larger ones. 'This kind of fish is stow'd in bulk and keeps far better than the inferior sorts.' West Indian or 'refuse' fish was 'screw'd in casks in order for its better preservation'. 'Dumb [dun?] fish' which had been kept too long on the flakes was seldom sent to market, but apparently was preferred by the Newfoundlanders. The same product is mentioned in connexion with the New Hampshire schooner fishery on the Banks in 1791. 'The first or spring fare produces large, thick fish, which after being properly salted and dried, is kept alternately above and under ground till it becomes so mellow as to be denominated dumb-fish. This fish, when boiled, is red [!] and is eaten generally on Saturdays at the best tables in New England.' The resident fishing led to an increase in the population of Newfoundland, which in turn, necessitated a proper government.

In the middle of the nineteenth century, French vessels were still going in the spring to St. Pierre, taking three loads of fish from the Banks before returning to France. The fish was either dried in St. Pierre, or taken green to France to be dried and exported to the French West Indies and the Mediterranean. Bordeaux in 1880 took 33,000 tons of salt cod from the Banks, as well as about 3,000 from Iceland. French vessels arrived at Bordeaux from the Banks from June until the end of the year. There were twenty-five drying grounds, each of 75,000 sq. ft. available at Bègles. After three days' drying the fish were ready for the market. The cod lost 25 per cent by weight in this process, which was less than in the case of the Norwegian or Newfoundland fish. After curing, it was packed in 600-lb. casks for French West Indies and in 100-lb. barrels for European markets.

On the French shore of northern Newfoundland, where they still had rights under the Treaty of Utrecht, there is a description of operations in 1878 of 'the salting house where the process of splitting, boneing, cleaning and salting is prosecuted with amazing quickness . . . The fish are not laid out to dry until about three weeks before their departure for France, so certain are they on this northern coast that no fogs, which are so prevalent and dense on the south shore of the island, will continue to interrupt the progress of the fishery.' The exports of St. Pierre and Miquelon rose from 8,000 tons of dried fish and 2,000 tons of green fish in 1850, to 11,000 tons of dry and 35,000 tons of green fish in 1886. However, the annual exports of cod from Norway continued to rise, and stockfish 'dried in the sun until it is as hard as a stick . . . easily portable and carried by mules into the interior of Spain' was still stated to be competing with fish from Newfoundland.

At the end of the century the French fishing was still based on St. Pierre, some fish being dried there and the rest at Bordeaux. In 1898 there were 177 vessels engaged in this fishing, including fifty-three from Fécamp, thirty from Granville, and fifty-eight from St. Malo. The French right 'of fishing upon the coast [of Newfoundland] and of drying the fish upon the land' was terminated in a treaty of 1904 in return for a payment of 1,375,000 francs. Exports of salt cod from St. Pierre had, however, fallen by half between 1886 and 1903. The *Terre-neuvas*, which were usually three-masted sailing ships (also known as *voiliers*) each carrying a dozen small dories that were used for catching the fish, also fished off the coasts of Iceland and Greenland, returning to France with their cargo when complete.[18]

In the Iceland fishery, as described by Pierre Loti in *Pêcheur d'Islande*, published in 1886, fish were apparently caught by lining from the main vessel which was manned by six men; and the season lasted from February to September, after which the vessels proceeded to 'the Gulf of Gascony, where their catch sells well, and to the sandy, salt-marshed islands where they buy the salt for their next voyage', before return to their home ports in Brittany or Normandy in December.[19]

By 1900, the introduction of steam trawlers had led to the gradual disappearance (virtually complete by 1914) of the St. Pierre fleet. The introduction of steam had made a *pied-à-terre* there and on Newfoundland superfluous. French trawlers appeared on the Banks in 1904 from Boulogne, Bordeaux, etc. and the small fishing villages of Brittany began to decline. Since the steam trawlers which still salted at sea caught fish at a greater rate than the old sailing liners, they had to be relieved of their cargo periodically by *chasseurs* or carriers.

The relative suitabilities of various types of cured fish for the Spanish market are discussed in a French account published in 1911. In Granada and Malaga 'merchants prefer [English and United States] cod for this reason; they keep, and if they must stand over in the warehouse the merchant's mind can be at ease. It is not the same with the French cod. Though of finer quality than the foreign fish, less salt goes into its curing. It is softer than the English cod which goes harder after it has been stored for a certain time. If the temperature rises, the French cod very quickly begins to be the worse for it. Around the bones reddish spots commence to come out [due to 'pink' bacteria, *see* p. 180]. They are the first signs of decomposition and it takes place because the fish are not dry enough to stand climates that are hot and humid . . . However, Andalusia being a colder country, the French cod can find a market there.'

Portugal tried to re-establish a Banks fishery in 1835, taking fish to Fayal and Lisbon to be dried, but the company soon disappeared, and not until trawling was well established after 1918 did her production again become significant. It then increased from 3,500 tons in 1919, to 12,000 in 1921 and 18,000 in 1924. The fish was brought home in November and December and cured.

Until about 1855 to 1858, the New England Banks fishermen fished by line from the deck of the ship. About that time they went over to fishing from smaller boats, 'dories', which by their greater movement attracted the fish. Their procedure about 1839 after getting the fish aboard the ship was described in somewhat more detail in the following account.

'The operators being placed in juxtaposition before a bench or platform about mid-height, the "cut throat" seizes the fish and separating the connecting integuments between the head and body, he then passes his knife through from the nape to the vent and abstracts the viscera. He then passes it to the "header", who by an adroit process separates the articulation of the spine at the shoulder and detaches the head from the trunk, which he passes to the "splitter", who, commencing at the shoulders, proceeds to lay the fish open to the tail and detach the sound bone.' An 'idler' (in name only) kept the men supplied with fish. 'The fish being thus prepared is thrown into the hold to the "salter", who strews on the salt and stows it neatly away in compact layers with the skin down . . . When the vessel returns she is moored head and stern at about a cable's length from the shore and the crew proceed to wash out the fare (cargo) . . . by unloading it into boats, taking it into about eighteen inches depth of water' or else it was pitched into a tank or old dory containing water, where it was washed clean by brushing to remove slime and dirt from skin and flesh. It was then wheeled on barrows into the salting building where it was placed in 'water horse', that is, stacked up in a pile with the skin up, to drain; from thence it was taken to the 'flakes' to be dried. The flakes consisted of 'a series of horizontal hurdles (sometimes of brushwood) at a convenient height from the earth on which the fish were spread and turned over from time to time.' It was covered up when it rained because 'it ought never to be wet from the time that it is first spread till it is boiled for the table.'

An account of the Bank trawl line fishery in 1879 gives more details of salting procedure on board the ship. It makes it clear that although the process was quite primitive, there was a good deal of 'rule-of-thumb' experience and skill required for its successful operation. The fish were gutted and split on the deck, as described above, saving the liver and often the 'sound' (swim-bladder) and tongue as perquisites. 'Sometimes sounds would be dried in the rigging, or in the cabin or fo'c's'l for sale to isinglass factories.' They were ground into pulp, and rolled into long thin sheets. Isinglass was used for refining beer and other purposes. 'In salting we make the first kench across the forward part of the hold . . . four or five feet wide fore and aft and wider at the bottom than at the top.' Some salters used their bare hands, but the majority preferred to use a scoop. 'No part of the work . . . requires so much care and judgement as the salting. The salters must have a perfect knowledge of how to test the strength of the salt, know at a glance how much salt each fish requires and on what part the most is needed. Otherwise the fish either come out "slack" and strongly smelling for want of salt, or "dry as a chip" from over salting . . . When the fish settle . . . they are "packed-up" by removing a portion from the after kenches and packing them on top of those which are forward, until the latter extend up to the deck. After this process has been two or three times repeated, the settling does not amount to much.'

One is reminded forcibly in these descriptions of old 'Uncle Salters', 'the best splitter in the fleet' on the Grand Bank in *Captains Courageous* by Rudyard Kipling, first published in 1897. This book, although in novel form, vividly depicts a still thriving industry of schooners from Gloucester, fishing from dories for cod and halibut on the Banks from March to September, and not returning until they had 'wetted all their salt'.[20]

On the Labrador coast, the fish were salted on shore by piling in kenches, head to tail and salting profusely between the layers. After remaining there for three weeks they were then piled upon flakes to dry. At the end of three days they were said to be 'made'. After this they were again piled in 'kenches' for a day to 'sweat', and once again thrown upon flakes for further drying: they were then ready to be stowed in bulk in the vessel. In the Labrador climate, considerable difficulty was experienced in drying the fish sufficiently. Sometimes the fish had to be turned to dry them on both sides and sometimes they were still not dry enough, so they had to be taken out of the ship at Gloucester and dried again. At other times the fish were not dried at all until they reached Gloucester.

The livers were preserved in liver butts ('gurry-butt' in *Captains Courageous*). These were huge casks mounted on skids and lashed down by strong ropes with a large square opening in the top. The livers putrified in the heat of the sun and 'as the oil begins to make its appearance at the top of the casks, or "makes out", it is dipped out into the water barrels and stowed away in the hold', in barrels, and more livers added. Fifteen barrels of oil were usually obtained for every 800 quintals of fish produced, sixty barrels of livers yielding twenty to twenty-four barrels of oil. The livers were fattiest in mid-summer and had least oil in the winter. The Bankers produced oil of poor quality that mostly went to the tanners. After the first 'natural' separation of oil, the mass of refuse blubber was allowed to remain until the vessel arrived home, when the blubber was boiled to extract the remaining oil.

However, in the United States during the latter half of the nineteenth century, improvements in transport consequent upon rapid industrialization facilitated the expansion of the market for fresh fish, so that by 1870 salt fish was beginning to become a by-product of the fresh-fish industry. As in Britain somewhat earlier, fish were being salted in some fisheries only when they could not be brought in alive or preserved in ice. Thus in the case of the fishery on George's Bank (the New England analogue of the Dogger Bank) about 1875, the last caught fish were being iced and even salted fish were being brought in round, particularly in the winter when they would keep better. They were gutted, without splitting, and a handful of salt was put inside each fish. The fish were then split and salted ashore. If salted at sea, less salt was used in curing than was the case on the Grand Banks, because it was necessary to keep the fish for much less time in the vessel.

The United States also imported salt cod, although the imposition of tariff barriers interfered with this trade. Thus in 1885 the Boston Fish Bureau protested, in vain, that: 'We need the hard dried cod fish of Newfoundland and the choice slack salted cod fish and pollock of Nova Scotia.' On the other hand, in Newfoundland and Canada—as it became in 1886—salt-fish production has continued to be of importance, particularly in the former, until the present day. In Newfoundland, too, the population was practically entirely dependent on fishing for its livelihood. In mid-century, St. John's is described as engaged in 'fish hauling, varied with fish curing and a noisome way of extracting seal oil by putrefaction.'

OIL

Although whales and seals are mammals and are therefore strictly outside the scope of this book, they were killed almost entirely for their oil or blubber, and the process used for rendering this had affinities with that used for cod-liver oil, which has always been an important by-product of the cod fishery.

The fat was placed in strong wooden cribs twenty to thirty feet square and twenty-five feet high, which were set up in strong wooden pans three or four feet longer than the cribs and three feet deep. The oil melted and ran into the pans, the first run off being known as pale seal oil. The process lasted some six months and involved a horrible stench. When they were burnt down in 1846 they were rebuilt on the opposite side of St. John's harbour. A man named Archibald claimed to have invented the steam process which rendered oil in twelve hours, as well as producing a better commodity. Plants using steam were built to take 4,000 pelts every twenty-four hours. In 1852, 2,000 tons of seal oil were sent to the U.S.A. for use as illuminant, but it was not very popular owing to the objectionable smell in such a warm climate.*

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* Until the end of the eighteenth century the wicks of oil lamps were flat, exposed and not impregnated, so that they were consequently very smoky and smelly. The oil lamp with the tubular wick so that air could get inside it, and a glass chimney which gave an upward draught, resulting in more light and less smoke, was invented by Argand, a Swiss, in about 1781.[21]

About the same time, too, the production of cod-liver oil was being revolutionized. Previously it, too, had been 'prepared' by allowing the livers to rot, by self digestion, in large vats exposed to the sun and air. Drummond and Hilditch[22] described the process as follows: 'Gradually, as the mass decomposed, there rose to the surface a layer of golden brown oil, which was separated after weeks or often months of standing. Other methods involved the heating of the livers in pans over open fires, or placing them in cloth bags through which the oil would drip as it slowly exuded from the pulpy mass . . . Such oil was deep golden brown in colour, possessed a highly objectionable flavour and a strong fishy smell.' This product was used chiefly for dressing leather. However, as a result of clinical trials of its use for the treatment of bone infections by Dr. Samuel Kay who was a physician at the Manchester Infirmary from 1752 to 1784, followed by similar experiments by Dr. Schrenk in Germany, published in 1822, it was in fairly general use as a medicament in Western Europe by 1840.[11] It is now known, of course, that cod livers contain the oil soluble vitamins A and D, of which the latter is necessary for the development of the bone of young animals and its lack produces rickets.

The recognition of the medicinal qualities of cod-liver oil led to the demand for an improved technique which would yield a more palatable product. A certain Charles Fox of Scarborough was the first to employ a more rapid and cleaner method upon which the modern procedure is based. Scarborough was just being used in the eighteen-forties as a port for the trawl fishery then developing in the North Sea. Perhaps to get better supplies of cod, Fox migrated to St. John's, Newfoundland, where in 1848 he introduced his new technique, consisting of heating the livers indirectly in a hot-water or steam-jacketed pan. He also first emphasized the importance of using only fresh, sound livers and of removing gall bladders which contain bile acids and would confer a bitter flavour on the oil. The oil was much paler in colour and for a time there was even prejudice against it for that reason. The steaming process was introduced into Norway by Moller in 1853, where it was soon widely adopted and it was not long before the 'rotted' brown oils had disappeared entirely. Before 1885, the Norwegians introduced a method of removing the stearine, which made the oil cloudy when it was cool, by chilling and pressing through filter cloth. Livers brought to New England ports fresh from George's Bank about 1885 were chopped up into small pieces and cooked by steam in tanks. Chopped livers were supposed to yield more oil than whole ones. The oil thus removed was put into five-gallon cans and packed in a large trough with ice and salt for twelve hours, and then put into bags and submitted to pressure, the solid stearine thus removed going to the tanners.

In 1903, Newfoundland introduced a process for rendering most of the oil by means of direct steam injection into a single pan. This is substantially the method used on British trawlers to this day for the livers of cod and related species. Halibut livers, which were shown in the nineteen-twenties to be very much richer in the vitamins, particularly A, contain less oil than cod livers, which is therefore extracted by the more thorough process of digestion with alkali.

ATTEMPTS TO IMPROVE SALT-CURING

From time to time there were criticisms of the Newfoundland salt cod. A Select Joint Committee of the Newfoundland Assembly reported in 1863: 'The cure of fish, your Committee believe, may be much improved by washing it immediately after it passes from the splitting-knife, and salting it while fresh; cleanliness . . . would . . . secure at all times (except when unfavourable weather prevents) the desired improvement . . . the practice of pickling cod fish, instead of salting it in bulk, after the old fashion, is very pernicious. The fish so cured will not keep in humid climates, or stand a long sea-voyage.' In 1913, precisely the same complaints were again made in a Board of Trade report: 'The utmost cleanliness should . . . be observed in the operations of splitting, washing from the knife, and dry salting as opposed to the pernicious process of pickling which in many localities is but too common.' Pickling no doubt took less labour and was easier to do uniformly.

Quebec in the mid-nineteenth century still relied largely on cod fish production for its very existence. According to a writer in 1871 'in the peninsula of Gaspé the cod fish forms the basis alike of food and amusement, of business and general talk, of regrets, hope, good luck, everyday life.' In 1859, 5,000 tubs were sent by one firm to Brazil. 'Each tub contains 128 lb. of well-dried fish. The packing is done by means of an iron screw worked by three men, the fish being thus pressed in the tub and forced into the smallest possible space.' In Brazil it was in competition with Argentine 'jerked' beef (from Peruvian *charqui* for meat cut into strips and dried), the price of which determined the price paid for salt cod. 'Jerked beef and cod fish are the two preserved foods used extensively in Brazil . . . It would not matter what religion they were; they would be obliged to have this form of preserved food', said a writer at that time.

Nova Scotia, too, was meeting difficulties in marketing its product and a Halifax Commission of Enquiry was set up in 1878. They observed that: 'We dry them more than they are dried in the United States but not so hard as in Newfoundland.' In a report on the fisheries of New Brunswick in 1852 it was said 'The Bay of Chaleur cod are more highly prized in the markets of the Mediterranean and will, at all times, sell there more readily and at higher prices than any other. They are beautifully white, and being dry, can better withstand the effects of a hot climate and long voyages than a moist fish.'

By the end of the nineteenth century salting and drying was being done less on a small scale domestic basis and was becoming more of a large-scale industrial process carried out under supervision. 'After catching, splitting and washing, the fish were put into three-quintal tubs with two gallons of salt per draft. [A "draft" and a half of fresh fish, amounting to 238 lb., yielded 108 lb. dried.] On the first day fish were added to the pickle formed by the salt. After four or five days they were washed in the pickle, put into the water horse, allowed to drain, were spread on the floor for six hours, and then put on the flakes or drying racks with the flesh side up. At night they were turned skin up and the following day turned flesh side up until early afternoon. On the second night they were placed in piles of three or four, skin up; on the following day spread out skin up, and on the third night put in piles of twelve or thirteen, heads out, tails in, with a large fish on top, skin up. On the fourth day, they were put in round piles of fifteen or twenty quintals to sweat. After "transpiling" on the fifth and sixth days they were left for seven days, put back on the flakes for three hours' sun and repiled for eight to ten days. This process continued for three or four weeks.' All this required considerable skill, experience, and labour to carry out.

With the development of fresh fish distribution, the liking for very salty products has diminished, and at the same time there has been a tendency towards lighter salting and softer drying and therefore more perishable products, which have to be distributed and consumed fairly rapidly. Thus, shore fish could be more lightly salted than fish caught on the Banks, which required plenty of salt to keep them until they could be landed. The use of cod traps led to catches in areas where drying conditions were bad. In Labrador, where curing was difficult owing to the shortness of the drying season, a fairly soft cure was produced which had to be rushed to market because it did not keep well. Much of this more lightly salted product was used for the preparation of 'boneless cod'. This was 'the trade name for cured cod or other fish divested of skin and bones and cut in pieces three to eight inches in length for convenience in packing'. This business was begun in Gloucester in 1869, when a limited quantity of the lower grades of cod and hake were packed in soap boxes and peddled in Boston. By 1879 nearly 7,000 tons were shipped from Gloucester to all parts of the United States.

Lightly salted products really needed cold storage, and some Newfoundland firms erected and maintained such cold storage depots in Spain, e.g. there was one at Alicante, owned by the firm of Hawes, which is still very active in the trade.

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Chapter 7

WHITE FISH SALTING AND DRYING (II)

North Sea and Home Waters—Recent History

Although from the seventeenth century onwards the distant waters, chiefly Newfoundland, provided the bulk of the salted cod consumed by the western nations, there were also smaller, but nevertheless thriving, fisheries in the North Sea as far north as the Shetland Islands and also off the north-west coast of Scotland.

THE DUTCH WHITE FISHERY

In addition to their flourishing herring fishery which was at its height at the beginning of the seventeenth century, the Dutch also fished all the year round on the Dogger Bank for cod, ling, tusk, and haddock with about 400 'pinks', which were flat-bottomed square smacks, and narrow-sterned well-boats, in which the fish could be kept alive.[1]

'Besides all these Pinks and Welboats', complains Tobias Gentleman in *England's Way to Win Wealth*[2] in 1614, 'the Hollanders have continually in the season another Fleete of fishermen, at the North-east head of Shotland [Shetland], which be of another quality, and there is more than two hundred of these, and these be called Fly-boats, and these do ride at ancor all the season at Shotland, in the fishing grounds, and they have small boats within them which be like unto cobles the which they do put out to lay and hale their lines and hookes,'* (baited with small fish or early herrings, allowed to be caught for the purpose) 'whereby they do take great store of Lings, the which they do not barrell, but splet them and salt them in the Ships Bulke, and these they sell commonly for foure and five pounds the hundreth, and these go by the name of Holland-lings, but they are taken out of his Maiesties Seas, and were Shotland lings before they tooke them there, and for these lings they do carry away abundance of Englands best money daily.'

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* 'Hoekschen' was the name adopted in the fifteenth century by a political party in opposition to the 'Kabeljauen' (or 'cod-fish') who supported the dynasty of the Counts of Holland.[3]

The Dutch hook fishing in the North Sea for cod, etc. and plaice, still continued until the middle of the nineteenth century. Thus, in 1853, thirty-five ships made 112 voyages, returning with 8,078 barrels of salt fish and 14,185 live fish.[4] The Dutch hookers also visited Iceland. In 1751, seventy-three ships caught an average of twelve lasts, i.e. a total of nearly 450 tons, and in 1770, 126 ships totalled nearly double this. The catch was very variable, fluctuating from two to twenty lasts in a season. Just before the French revolution the yields were very poor indeed, and the number of ships engaged had fallen to about fifty. Up to the middle of the nineteenth century, only a few Dutch ships occasionally went salting to Iceland. Thus in 1853, six ships brought back a total of 140 lasts (280 tons).

BRITAIN

It is also reported at about this time that about fifty Yarmouth ships of 50 to 150 tons and as many from other British ports fished every year, chiefly for ling and cod, salting at sea, until 'about Bartholomew-tide' (24th August).

Towards the end of the eighteenth century, Barking smacksmen were developing a distant water cod fishery as far afield as Iceland, which they combined with the landing of live fish mentioned by Defoe in 1724[5] (*see* p. 204). This fishery was based on techniques they had developed of fishing by hand line, with a few baited hooks, and by long line, with hundreds of hooks, hauled by a capstan, in the deep channels of the Thames estuary (*see* p. 207).

In 1805 there were at least twenty-three smack owners at Barking. After the peace of 1815, the smacks resumed Iceland voyages for cod caught by lines. Originally single-masted cutters, this rig gave way to two-masters, with a small mains'l and a mizzen mast, which made them more handy for fishing. The Iceland voyage in the summer took about fourteen weeks. The fish were split and wet-salted at sea. A splitting board was fixed up on deck. 'Then rows of cod were laid out, a man grabbed one, ripped it open and removed liver and roe, threw the offal overboard, and flung the fish to the next man, who chopped off the head before passing the carcase on to the splitter, who split the fish open from head to tail and removed the backbone.

After being washed clean of all slime, blood and offal, the cod were passed below-deck to be salted and stacked away in tiers . . . from 20,000 upwards (was) considered a good trip.' The first load was landed in Shetland, Orkney, or north-east Scotland where it was dried and then taken to Liverpool by larger vessels and thence exported to the Mediterranean. The second load was more likely to be landed in Orkney or Shetland rather than the mainland if weather was unfavourable or time was getting short. The third trip would include live fish if it were a well vessel (*see* p. 214). If 'dry bottomed', the third and last cargo would be brought to Billingsgate, although by the middle of the nineteenth century, there was not much demand for it there owing to competition from the increasing supplies of fresh fish, so that the salt fish was frequently sent further on to the south coast, e.g. Portsmouth. Grimsby welled smacks, too, entered into this trade, bringing their choicest fish back to port alive on their last trip before laying up for the winter. In 1872 there were sixty-two of these cod-smacks of 44 tons average burden, with the usual crews of about fourteen (*see* p. 209).

Methods of hand- and long-lining were improved as experience was gained, and the vessels were larger by the eighteen-sixties so that they could go farther north in the summer, even into the Arctic Circle. On one occasion, a well-smack sighted Jan Mayen Island.

THE SHETLANDERS

The population of the Highlands and Islands of Scotland largely relied on fishing for their subsistence. In the Shetland Islands up till the first part of the eighteenth century, the salt fish trade had been dominated by the Hamburg, Bremen, and Dutch traders who bought the local production and, of course, by the Dutch fishing. A book published in 1641 mentions 'Hempe', 'Pitch and Tarre', 'Barrels, boards and Willow hoopes', 'Lixboan [Lisbon] salt' and 'salt upon salt made in England' as figuring amongst the Dutch merchants' imports for the Shetland herring fishery. The Bremen Booth, on the Island of Whalsey, probably dates from this period.

All this trade came to an end with the introduction of the salt tax in 1712. Encouraged by 'bounties' of 3*s*. per cwt., the local 'landmasters' (i.e. land owners) stepped in to replace the foreigners in the curing of cod and ling. They made the supply of fish for curing a condition of tenure of land held by crofters, who were forced to deliver as large quantities of fish as could be obtained at stated prices. The landlords acted as dealers and supplied lines and hooks and boats, with few or no cash transactions taking place. The memory of this prolonged period of exploitation is still very much alive in Shetland today.

The deep sea fishing that sprang up was called the *haaf* fishery from the Old Norse word *haf* (cf. Norwegian *hav*) meaning 'ocean'. Stations were established at the extremities of the islands to minimize the rowing distance to the fishing grounds. The stations consisted of 'bothies' (or huts) where the cod were split and salted and stony beaches for laying the fish out to dry. Halibut taken on the lines were not welcomed, because there was no market for them salted in Europe, unlike the United States. In fact, there was a period when they were used only for making it easier to pull the boats up on to the shore. The six-oared open vessel, or 'sixern', with an 18-ft. keel, held six or seven men or six men and a boy, who rowed thirty or forty miles to the fishing grounds and back twice a week in the season May to August. The life was arduous and perilous in the extreme. A July gale in 1832 swept away seventeen boats with 105 men, and again in 1881, ten boats were lost with fifty-eight men, six crews coming from one 'township', which was thereby almost obliterated. In 1784 'most fortunately, which seldom happens, not a single boats crew has been lost' says one record.

At the same time it must be admitted that under the stimulus of this industry the population of the country increased between 1755 and 1793 by 5,000, compared with only one hundred for Orkney, which is much more suitable for agriculture and therefore less dependent upon fishing.

Between 1700 and 1759, the fishermen received 3*d.* for a ling and 1*d.* for a tusk. The landlords traded with Hamburg and in the late seventeen-twenties were endeavouring to obtain access to the Lisbon market. Custom-house records for 1742–8 reveal that 300 to 400 tons of dried cod were exported annually from Shetland entirely to Hamburg. There were also much smaller quantities of 'wet cod' in barrels and cured, 'white' herring, and the salt-fish trade was supplied by an import of foreign salt.

In 1763, London merchants penetrated the market and sent the Shetland ling to Barcelona as Greenock merchants had also done some four years earlier. The price of ling then rose to 4*d.* per fish for the fishermen. In the seventeen-eighties, 600 to 700 tons of ling, tusk and cod were being sent coastwise or exported. Assuming ling of average length 27 in. running twenty-five to the cwt., this amounts to at least 300,000 to 350,000 fish, since tusk were smaller than ling. The port of Lerwick accounts for 1775 show that one curer, Gifford, was of outstanding importance, his catch and cure of 120 tons out of 400 tons being greater than the total of the next nearest three men.[2] Ling supplied between 70 to 90 per cent of this, and there was in addition about twice as much tusk as cod. In 1779 and 1780, the price went up to 6*d.* for a ling and 2*d.* to 2½*d.* for a cod, but the Napoleonic Wars led to reduced demand, so that whereas formerly the bounty was paid on fish exported, now it was paid on fish cured.

The technique used by the Shetlanders for salting the cod, ling and tusk caught in the *haaf* fishery, as described in 1769, differs very little from that used at other times in other places. 'As soon as they are landed, the heads are chop'd off, the guts taken out, and, the body split down to the tail, the backbone is cut out. They are then laid down in a large vessel with alternate layers of bay salt and having remained there for some days, they are removed either into another similar vessel with alternate layers of salt, or they are spread out to be dried on the stony beach, their insides being exposed to the sun and air. As rain injures them greatly, they are every night collected into conical heaps and spread out again if the morning be dry, till being fit for the market, they are kept in dry places.'

Wherries of 20 tons burden from Ireland also commenced fishing in Shetland waters about 1780, presumably salting their fish at sea, but operations had ceased by the end of the century because the salt was seized by the Customs on the grounds that it was imported without paying duty.

The islanders were particularly harassed by the salt duty (*see* p. 100). Interesting light is thrown on the fishery by some of the complaints made from time to time, e.g. the 'Memorial for the fish curers on the coast of Scotland, particularly those on the Shetland Islands, relative to an Act passed the 10th of

May last, imposing an additional duty on Salt' signed at Edinburgh on 2nd June, 1798. 'The principal fisheries in Shetland are the Ling Tusk Cod and Saith fishing. The ling and cod are chiefly exported and receive a Debenture of three pound per ton, without which support from the Government, the fishery could not be carried on, for this obvious reason, they would be undersold by the Danish, Northern fisheries, which are conducted at less Expense. Such fish as are not free for exportation are for the most part Sold to the poor, and, from their quality cannot afford a duty. The Tusk, cannot Stand a long voyage and are all cured for home consumption. The Saith fish, are the food of the poor and are wholly consumed in Scotland . . . There is annually cured in Shetland 1,000 Tons of fish and salt is laid in for the ensuing fishing in February, March and April. As usual the Shetland fish curers imported this year the necessary quantity of English, and Scots, salt, duty free, trusting that if a foreign market should fail they might enter them for home consumption.'

THE END OF THE HAAF FISHING

The Shetlanders' *haaf* fishing, brought into being by the salt duties, survived their repeal in 1825 and lasted into the twentieth century. However, as the nineteenth century advanced, the 'sixerns' had to penetrate farther and farther into the open sea to find fish. After the gale of July 1832, which struck a heavy blow at the fishing, a half-decked boat was introduced, apparently against the will of the men, who probably foresaw intensified exploitation. However, by the eighteen-seventies it had become 30 ft. over-all in length and fully decked, and the steam capstan was introduced by the end of the century, although the 'sixerns' lingered on until 1896 as herring boats.

When Christian Ployen, the Danish commandant of the Faroe Islands, visited Shetland in 1839, the industry was still in full swing.[6] He visited the fishing stations of Messrs. Hay & Ogilvy at Scalloway and on Burra Isle, where they salted and dried cod and ling. Fishing was carried on from the middle or latter part of May to 12th August, which fitted in well with the crofter's seasons of sowing and harvesting.

The fish was cured by special workmen employed by the lairds. The fish, which was cut across the neck so as to bleed freely as soon as it was taken off the hook, was well washed in sea-water as soon as it was landed and then kept overnight in clean sea-water on the beach. Next day it was split from neck to tail with a large and very sharp knife, washed carefully with a brush made of heather, to remove all blood and slime, scrubbing from the neck down towards the tail. The fish was then laid in salt in large vats made of boards and very tight, about six feet square and four feet high. The bottom of the vat was first strewn with salt, then a layer of fish was placed in it with the skin side lowermost, then more salt and so on. The whole was weighted down with stones to keep the fish under the brine, where it remained for three days and nights. After taking out of the salt, it was rinsed in a mixture of salt brine and sea water, otherwise it would be covered when dried with a white crust of crystallized salt. The fish was then heaped together to drip in stack for three days and finally spread, first with the skin side lowermost on a flat broad beach of small stones, which, being loose, admitted some draught, and did not get so hot in the sun as rocks. Every evening it was heaped together again, the first two or three times in small heaps, afterwards in larger ones as it became drier. As far as possible, all fish received the same pressure, those that were uppermost one day being lowermost the next. When heaped in stacks, it was covered over with nets on which pieces of wood and large stones were laid to increase the pressure. Care was taken to protect from the weather, by piling and covering up when rain threatened.

Ling, it was considered, could stand all the warmth it could get, but the skin of cod was apt to crack if it got too much sun and the latter was therefore laid with flesh side uppermost and only turned over in the cool of the evening. When properly dried, the thin black peritoneal skin lining loosened and was peeled off. While awaiting shipment, it was kept in dry stores lined with boards and covered with a double layer of nets. Salt ling fetched £2 per ton more than salt cod in Shetland, at a time when, Ployen remarked, the Faroese were not even making stockfish from their ling.

Fishery officers examined every fish and stamped those they passed as good with a small hammer which made a square hole in the tail. This was a relic of procedure before 1829 when bounty payments by the Government were abolished. Salt cod and ling, which unlike the barrels of salted herring could not literally be 'Crown branded' (i.e. burnt by a red-hot iron of that shape) either had their tails cut off, or else had the shape of a miniature crown punched out of them, to prevent them from being submitted again. In the time of Ployen, apparently, Crown branding was still being used as an official guarantee of the quality of dried, salted cod, as it was a century later for salt herring.

The saithe, too, was made into salt fish, although the product was rather greyish in colour.

By this time the great fish-curing companies had acquired a complete monopoly grip on the islands through ownership of the stores, according to evidence given to the Truck Act Commission at Edinburgh in 1871. 'The crews for the boats are hired in December or January and at the same time boys are engaged as beach boys. The boy is allowed to draw his coat to go to church with, and by the time the fishing is over the boy has overdrawn his account, and is thirled [tied] to be engaged for the next season, and he is thus thirled or trucked away until he is thirled into the grave.'[7]

In 1837, an unsuccessful attempt was made to break the monopoly grip of the land owners by Arthur Anderson, who also founded the P. & O. Steamship Co. He operated on the island of Vaila, off the west coast of the mainland, a large fishing station at which for the first time in Shetland fish were dried on 'flakes', in what Ployen called the Yorkshire fashion, using 'a sort of scaffold, something like a bedstead but closer and about six feet from the ground.' The advantages of this were that, since the fish were well above the ground there was no risk of 'scalding' or blistering by contact with hot pebbles when the sun was shining, and at the same time drying was quicker because the air got underneath the fish. But if dried too quickly it was 'very apt to get so quickly crusted over, that the inside ferments', a description of 'case-hardening', presumably.

In 1845, nearly $1\frac{1}{4}$ million fish were caught and 800 tons of product were exported to Ireland and the Continent from Lerwick, Walls (a district on the west coast of the mainland of Shetland which included Vaila) and Unst (the northernmost island).

In the second half of the century, the rise of the smack fishing off Rockall, the Faroes and Iceland began to displace the *haaf* fishery. The Shetland smack fishermen went considerable distances, to the Faroes and Iceland, and in 1846, Hay of Lerwick even sent some of his vessels to the Davis Strait where they had a good fishing for cod. Results were poorer in succeeding years and in 1850 it was dropped. A further attempt was made in 1862, but this fishing was then finally given up.

By 1877–8, the open boat caught fish had increased somewhat over the 1845 level, but the smack caught fish was by then just as high. In 1862, there were already about twenty landings per month from smacks, mostly from Faroe, and the catch per vessel varied from 1,000 to 9,000 fish. The smack fish had to be split and salted at sea, and the curing was completed by drying on shore.

In 1872, there were sixty-six cod smacks, averaging 44 tons, and manned by fourteen men apiece, sent out from Shetland every year, splitting and salting at sea as caught. Two or three trips were made between April and September. The fish were washed and dried in the open at Lerwick. This cure increased to more than 5,000 tons, but had fallen away again to 2,500 in the nineteen-hundreds.

The introduction of the Aberdeen steam trawler in the area in the late eighteen-eighties and eighteen-nineties led to the final extinction of the *haaf* fishing because trawled fish was so much cheaper to produce than fish caught on hand-lines with hooks every five fathoms.

It is interesting to note, however, that as recently as just before World War II, Swedish fishermen were still fishing for ling near one of the old *haaf* grounds sixty to eighty miles off the northwest of Shetland, using Shetland-caught mackerel as bait and sending the fish in ice to Sweden, where it was hard cured in the sun, particularly as a Christmas delicacy.[2]

MAINLAND INSHORE FISHERIES

White fish caught off the coast of Scotland was mostly salted and dried for export to 'Spain and the Straits' and France. In 1724 Defoe noted of the south bank of the Forth estuary, that 'There are great quantities of white fish taken and cur'd upon this coast, even within as well as at the mouth of the Firth; and as I had occasion to inspect this part,* I took notice the fish was very well cur'd, merchantable, and fit for exportation; and there was a large ship at the time come from London, on purpose to take in a loading of that fish for Bilbao in Spain.'[8]

At the beginning of the nineteenth century, there was a cod and ling fishery in the Moray Firth using large open boats, which went several leagues out to sea and stayed out for five to six days. But in the words of a contemporary writer, 'as they have no convenience for curing the fish as they are caught, they are obliged to let them lie in the bottom of their boats till their return, which greatly impairs their quality.'[9] In other parts of Scotland, white fishing was carried out in small boats, the fish being bled immediately it was caught, 'but as they must, from want of convenience, allow them to soak in their blood, and in the bilge and leak water of the boats, which are never remarkable for cleanliness, the quality of the fish cannot be much improved by that operation.' However, 'as the produce of each day's fishing is carried on shore and salted in the evening, the quality must on that account be much superior to that of the fish caught on the Moray Firth, though greatly inferior to what are cleaned and salted immediately after they are taken, as is done on board the Dutch and English fishing vessels.'

In addition, the intrinsic quality of inshore fish caught by the small boats in lochs and bays was supposed to be poorer than that of fish caught near headlands, in strong currents and in deep waters. The fish, which were caught in spring and summer on long lines, and in winter by hand-lines closer inshore, were also often much damaged by swallowing the hooks, whereas the English and Dutch hooked lightly by the lip, so that they could be kept alive in tanks, and also as a result of bruising and during struggling, and the depredations of crabs, etc. before the lines were hauled. By comparison, the English and Dutch cod and ling fishing at the beginning of the nineteenth century was carried out from small sloops and smacks and even the Yorkshire cobles were half-decked vessels of 20 tons burden, which afforded relative comfort and permitted greater attention to the fish. Scottish-caught ling were cured chiefly by

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* He was pretending to be looking for a glass factory or a salt works to buy whilst he was actually spying in Edinburgh at the time of the critical negotiations over the Act of Union (Sutherland, J., *Defoe*, London, 1937).

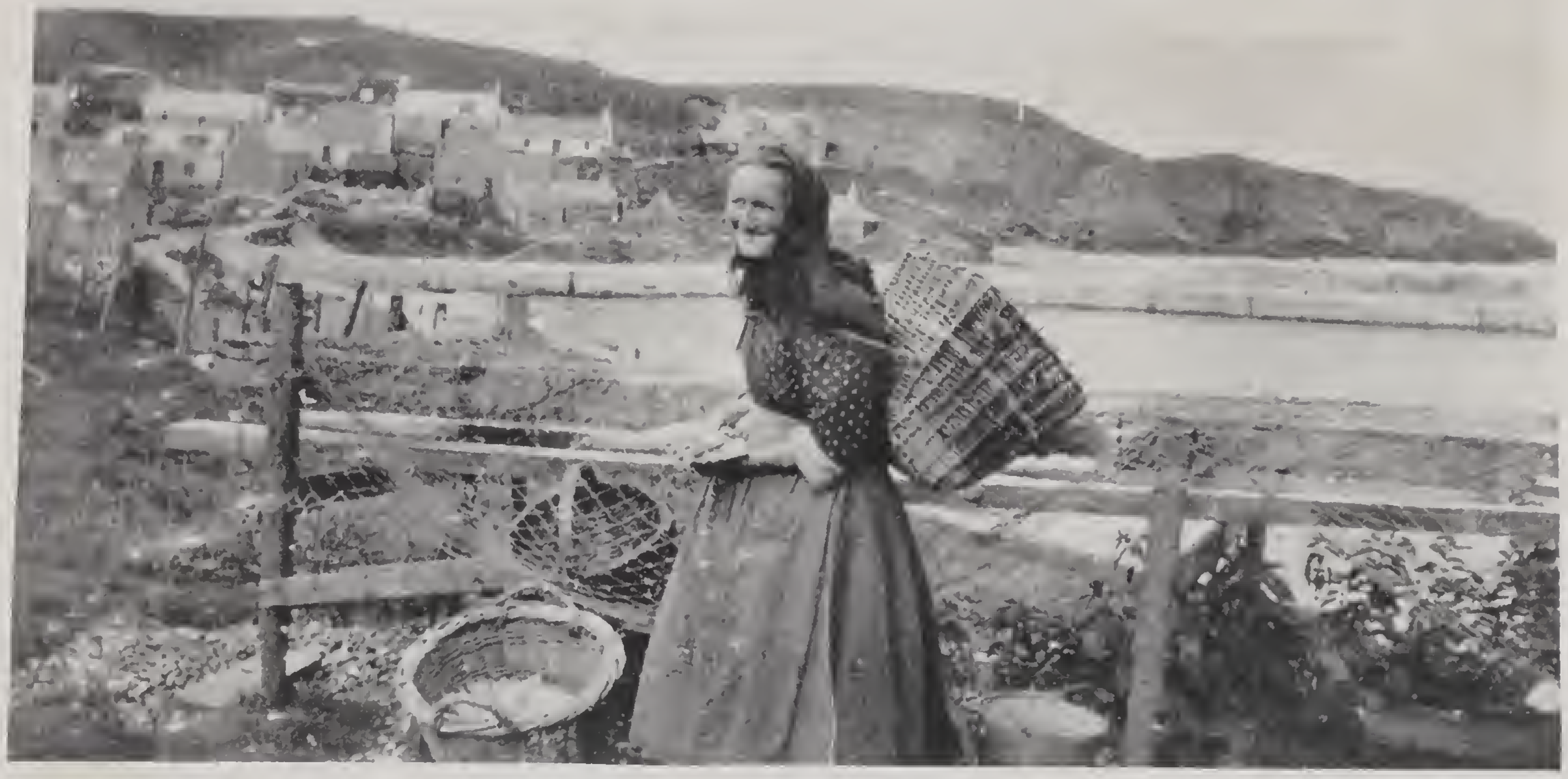
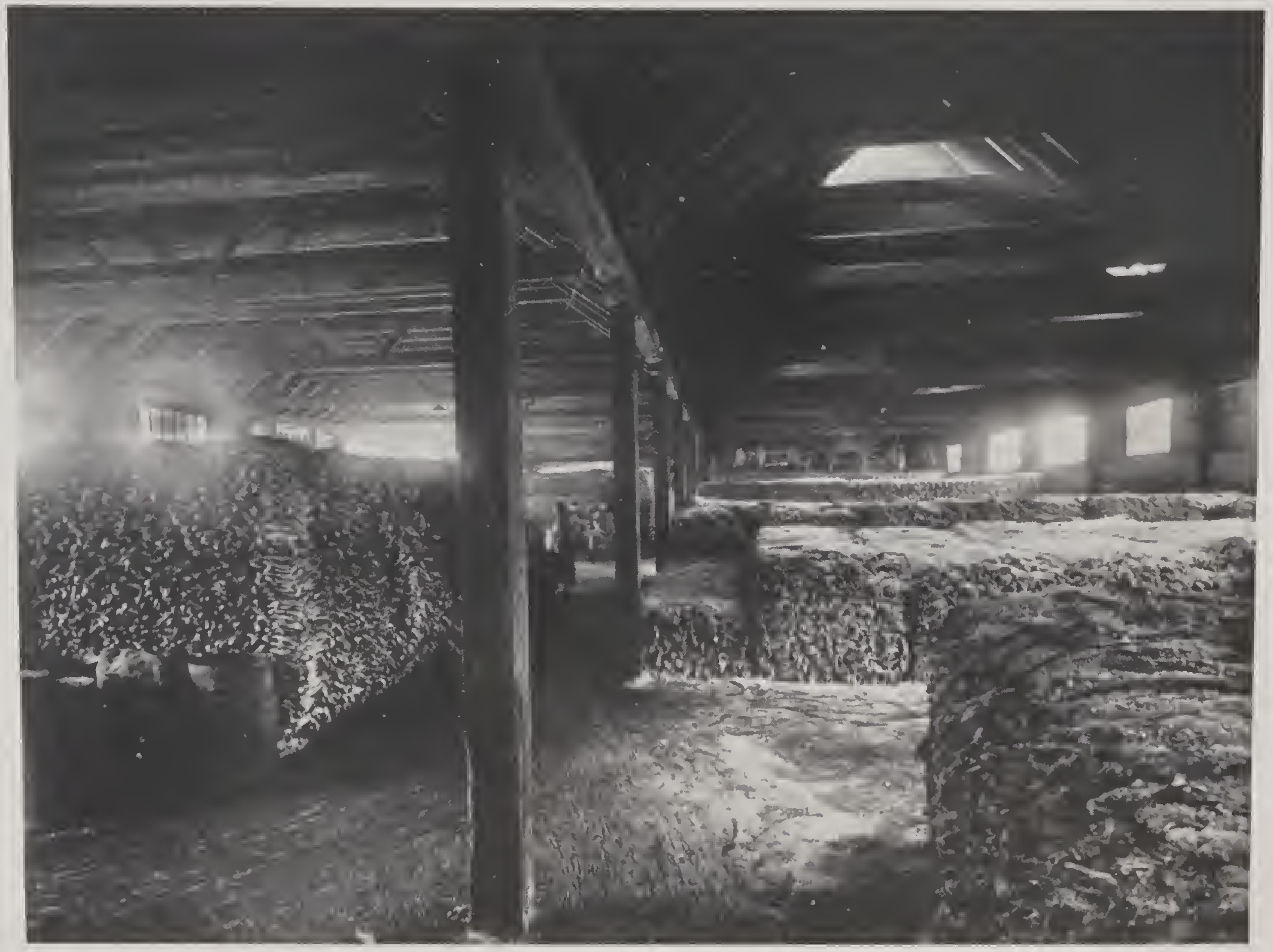


PLATE 10.—Speldin's dried by 'fish-wife' at Collieston, Aberdeenshire (about 1904).



By courtesy of J. W. Williamson Ltd., Aberdeen

PLATE 11.—Stacks of salt cod at Aberdeen (about 1910).

sun drying. Cod was either salted in barrels or sun-dried like the ling. A little was bulk-cured, i.e. presumably wet-salted without drying, and was said to be like the Iceland fish (again called 'mud fish' by this writer (*see* p. 120). This product, like the barrelled fish, was suitable only for the London and other home markets. The estimated annual production of sun-dried fish, about 1800, excluding Shetland and Moray Firth fish, which was sold on the east coast, was about 650 tons, of which Caithness and Orkney supplied 80; Fraserburgh and Peterhead and the coast down to Aberdeen, 80; the Long Island (i.e., the Outer Hebrides) and Lewis, 150; Skye and Oban, 60; Gairloch and Loch Broom, 40; and Barra, 200. There were also about 2,000 barrels of the wet cure, of which Caithness and Orkney accounted for 800, Fraserburgh and Peterhead, 800; and Gairloch, 200; and in addition about sixty tons of 'mud fish', chiefly at Gairloch. These quantities are small by modern standards, and reflect the inefficiency of the methods employed.

By 1800, too, the market for Scots fish in London was decreasing, chiefly on account of the recent expansion of the long line fishery on the Dogger Bank and the great increase in the live fishing carried on by well smacks, on which the fish choked during hauling were immediately cleaned and salted. However, Peterhead, about 1810, was still exporting 500 barrels of salt cod and a considerable quantity of ling.[10] Even in 1843, the smaller ports round Aberdeen were still active in salting cod and ling which were then shipped to the London market, and in 1847 the total quantity of cod and ling cured and dried 4,331 tons, and, pickled 6,247½ barrels, out of an estimated total of over 20,000 tons, was several times greater than the figures just given for the beginning of the century, if they can be relied upon.[11] On the Yorkshire coast, similarly, cod caught by local cobles was cured; and as late as 1874 at Staithes, between Whitby and Hartlepool, cod was still being split, salted, and dried on the rocks.[12] At Brixham from the seventeenth century onwards, whitings were split, salted, and sun-dried by the womenfolk to produce an article known as 'buckhorn', no doubt on account of the resemblance of its toughness and colour to those of the original.[13] This type of commodity did not disappear until the improved transport facilities of the nineteenth century increased the market for fresh fish.

Descriptions of Scottish practice given in 1849[11] and again in 1880[14] show that in the course of the century there had been no developments, either in process or product. It is once again insisted that the fish should be bled and gutted immediately they are taken off the hooks. After heading and splitting, leaving a piece of bone at the tail end in the usual fashion, the fish were washed and salted in layers with 45 to 50 lb. of salt per cwt. of fish for three days. They were then washed and allowed to drip ('dreep') in 'bings' (from the same root as 'ben' meaning hill, or heap), and dried on flakes or pebbles, on their backs at first and turned from time to time. At night they were taken up and piled into heaps which were kept pressed down with weights. When the fish were half dry, they were only dried with their backs uppermost, which was said to draw salt from the flesh side and thus improve the colour of the product. After fourteen days' drying they were lain in a pile to 'sweat' for ten days or so, covered up with cloths or mats. They were then dried for a further week and 'sweated' for another five days and finally dried for two or three days. The entire process therefore took about six weeks. A pickle cure was also made by immersing the split fish for forty-eight hours in saturated brine and repacking in tight barrels with salt between the layers, 80 to 100 lb. per barrel.

At Boddam, near Peterhead on the Aberdeenshire coast, in 1840, fish were still being salted and dried on the beaches and then smoked in their chimneys over peat fires,[15] chiefly by the womenfolk while the men fished. The forerunner of the 'finnan' haddock (named after the village of Findon, six miles south of Aberdeen) was probably a similar product. At Collieston, between Aberdeen and Peterhead, another characteristic local product known as the 'speldin' ' (also mentioned in the Household Book of James V, about 1520) was produced merely by drying in the wind so that a slight, agreeable, 'cured' flavour is developed (*see* Plate 10). Both these names are mentioned by Robert Ferguson (1750–74), who knew Aberdeen well, in verse 14 of *Leith Races*, published in 1773.

> The Buchan bodies thro' the beech
> Their bunch of Findrums cry,
> An' skirl out baul', in Norland speech,
> 'Gueed speldings, fa will buy?'

An', by my saul, they're nae wrang gear
To gust a stirrah's mow;
Weel staw'd wi' them, he'll never spear
The price o' being fu'
   Wi' drink that day.*

In the same year, 1773, Boswell tried without much success to induce Dr. Johnson to try the speldin', of which he gives a good description.[16] On 18th August, after crossing the water of Leith and just before they crossed the Forth, i.e. presumably at Newhaven: 'I bought some *speldings*, fish (generally whitings) salted and dried in a particular manner, being dipped in the sea and dried in the sun, and eaten by the Scots by way of a relish. He had never seen them, though they are sold in London. I insisted on *scottifying* his palate, but he was very reluctant. With difficulty I prevailed upon him to let a bit of one of them lie in his mouth. He did not like it.' In a footnote Boswell adds: 'My friend, General Campbell, Governor of Madras, tells me, that they make *speldings* in the East Indies [*sic*], particularly at Bombay, where they call them *Bombaloes*', presumably the same as the 'Bombay duck', which is a smallish and very narrow fish, boned and split, and dried hung upon lines in the sun and wind.

Later on in the *Tour* Boswell recounts: 'Thursday, 26th August [1773]. We breakfasted at Cullen [on the Moray Firth]. They set down dried haddocks broiled along with our tea. I ate one; but Dr. Johnson was disgusted by the sight of them, so they were removed.' Johnson in his account[17] says nothing of this, although he complains of the dinner the same day at Elgin, the only one in Scotland 'which we could not eat'. Johnson was no lover of fish. In Skye he confessed that 'it is because I am so short-sighted, and afraid of the bones for which reason I am not fond of eating many kinds of fish, because I must use my fingers.' But meat, too, when not to his taste, was the subject of some of his severest animadversions. Of some roast mutton at an inn he complained: 'It is as bad as bad can be: it is ill-fed, ill-killed, ill-kept, and ill-drest', remarks worthy of Matthew Bramble himself.

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* Sassenachs will no doubt be grateful for a few words of explanation. 'Buchan' is the north-east portion of Aberdeenshire; 'skirl'=cry out; 'baul'=boldly; 'Norland'=northern; 'gueed'=good; 'fa'=who; 'saul'=soul; 'nae wrang gear'='not bad fare'; 'gust'=taste; 'stirrah'=sirrah, or fellow; 'mow'=mouth, or maw; 'staw'd'=stowed; 'spear'=ask; 'fu' '=full, cf. Burns's *Death and Dr. Hornbrook*, 'I was na fu', but just had plenty.'

SUBSISTENCE FISHING

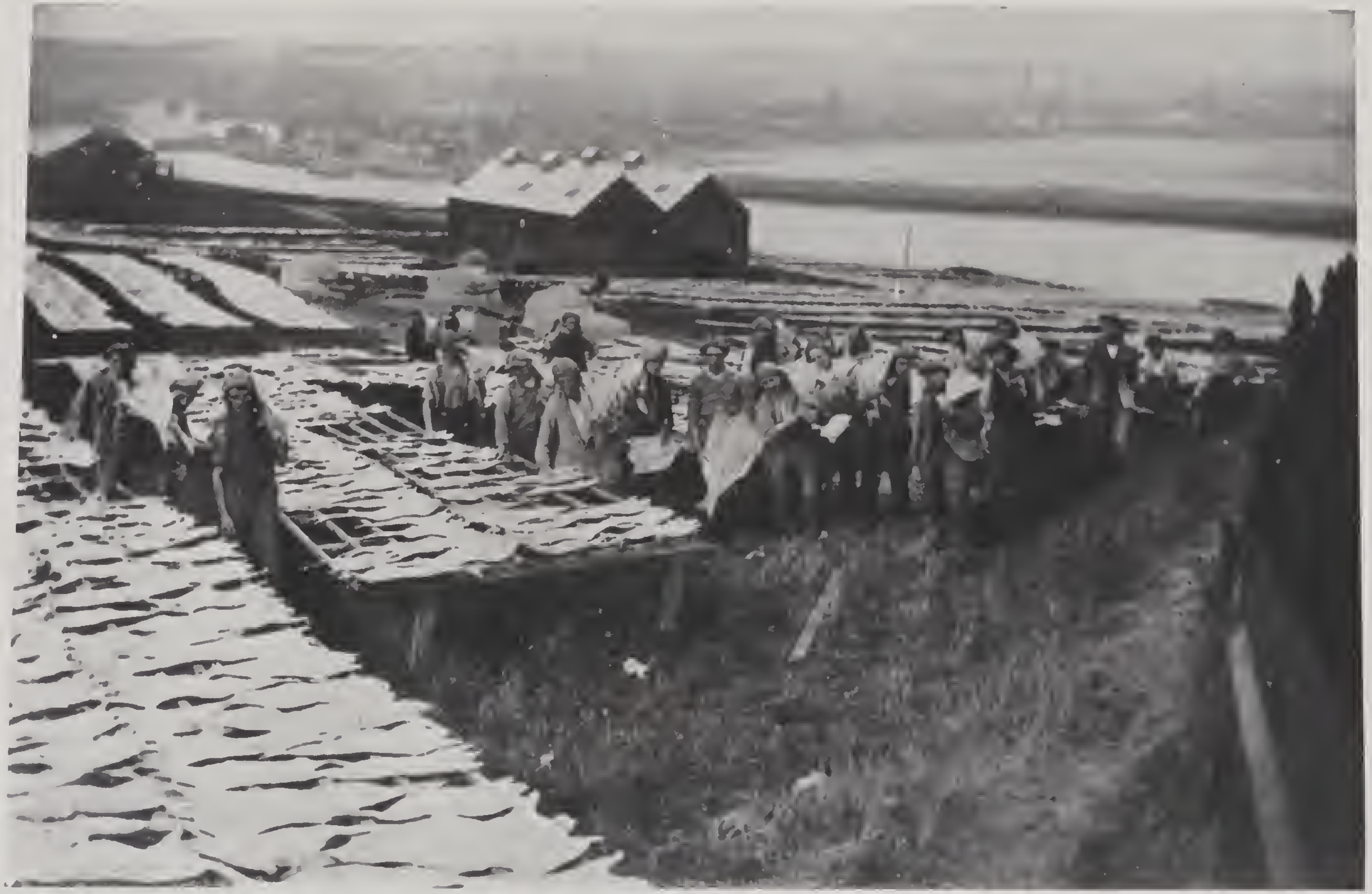
Quite apart from salt fish being, in a sense, a cash crop, the inhabitants of the outlying islands practically lived on fish until comparatively recently. In 1839, Ployen, the Faroese observer in Shetland, summed up two typical modes of existence.[6] 'The Faroese . . . live on dried fish [i.e. stockfish, for they made no salt fish at that time], the dried flesh of the whale and bere meal bread [made from a hardy cereal related to barley] (and) lard. The Shetlander's mode of living is fresh, half-dried and dried fish, with poor bread made of bere or oat meal.'

Various types of salted and dried products were made, some for relatively quick distribution in the locality and for home consumption. An account of Shetland in 1864, shows that haddocks were gutted and salted in barrels or dried for winter use. Young coalfish (saithe), gutted, washed in sea water, salted to various extents, and dried in the open for eight to ten days, were known as 'sookit piltocks' and are still considered quite a delicacy by Shetlanders. Generally speaking, however, the products then eaten—and still eaten with apparent relish until recently in the outlying parts of the country—would not be acceptable to most people to-day, owing to the highly developed flavours occasioned by delays in preservation.

Whereas in other parts of Scotland, haddocks were obtainable by the fishermen during the winter, the Shetlanders were still only able to catch cod, which, after salting, had to be stacked in heaps with additional salt in the open or in their habitations until the spring, when it could be dried. The smell on the windward side of these piles was quite remarkable,[14] but seems to have been no objection.

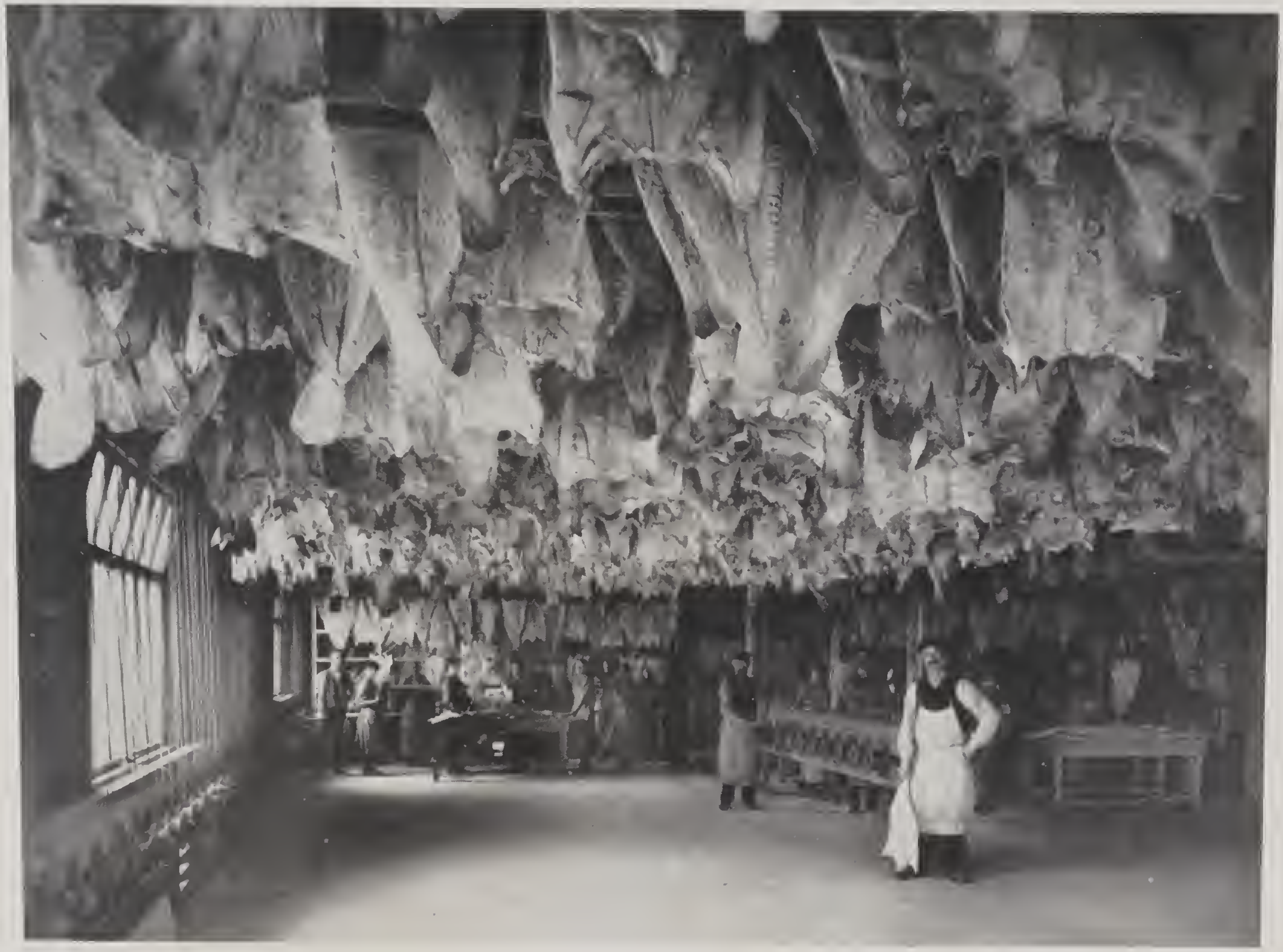
The Shetlanders also produced 'blaun' (i.e. presumably 'blown', by part drying in the wind) which is still occasionally to be met with. This was a mildly cured product, rather lightly salted and only dried for a day or two, and therefore intended for immediate use rather than long storage.

In spite of the dearth of food, however, not all the fish caught could always be utilized. Thus the Shetland account of 1864 shows that 'sillocks' (i.e. small saithe, about the size of salmon



By courtesy of J. W. Williamson Ltd., Aberdeen.

Plate 12.—Salt fish sun-drying at Balnagask Drying Station, Aberdeen (about 1910).



By courtesy of J. W. Williamson Ltd., Aberdeen.

Plate 13.—Salt fish artificial drying at Esplanade Curing Works, Aberdeen (about 1910).

parr, cf. the German name *Seelachs*, or 'sea-salmon' for this species) were caught between August and October 'for the sake of their liver, which contains oil.' This was used for lamps as in Hanseatic Bergen. 'The fish itself is taken to the dunghill, when the take is not great, but when there is a great take, the liver is taken out and the fish thrown in the sea.'

Johnson and Boswell in 1773 found the inhabitants of the Western Isles still largely dependent for their illumination on the liver oil of the young saithe (coalfish), called by them the 'cuddy' (from Gaelic *cudaig* or *cudainn*) from which 'they all know how to extract . . . oil for their lamps.' Both the travellers remark on its use in the Island of Coll, where since they had to spend a week in October on account of the weather as well as having the company of the laird for several more weeks, they might have had particular opportunity for detailed observation and notes in their respective journals. Johnson says: 'It is not much bigger than a gudgeon, but it is of great use in these Islands, as it affords the lower people both food and oil for their lamps. Cuddies are so abundant at some times of the year that they are caught like whitebait in the Thames, only by dropping a basket and drawing it back.' Boswell in his account adds: 'They all make oil of the livers of fish. The little fish called cuddies produce a great deal. They sell some oil out of the island and they use it much for light in their houses, in little iron lamps, most of which they have from England; but of late their own blacksmith makes them.'

In North Ronaldsay, in the Orkneys, where practically no wood is grown, it is even reported that fish were smoked over dried dung cakes. In the Hebrides, skate which was said not to 'take' salt, owing to the mucus extrusion for some days after death, was merely dried by being hung up in the open air. This 'sour skate', as it was, no doubt justifiably, called, was a favourite article of diet in the Highlands and Islands. In Shetland, skate was buried in the ground for a considerable period, no doubt with a similar highly flavoured product, as a result, smelling strongly of ammonia. In spite of, or perhaps because of, the flavour, it was regarded as a welcome change from the normal monotony of the diet. Dogfish, cut open and dried in the open, were sold in the Highlands as 'Darwen Salmon' (a name by which this species is still known in Lancashire), after removal of the rough skin to prevent identification. It, like the skate, must have reeked of ammonia, since the precursor, urea, is plentiful in the flesh of these species.

HALIBUT SALTING

Although cod and related species are by far the most important class of fish preserved by salting, there was a period when the catching of halibut for salting was quite an important industry in New England.

From the nearer grounds the fish could have been landed alive or in ice, but the Grand Banks which were first fished by New England ships between 1845 and 1850, were too distant for this practice at that time. First of all they were preserved by drying, but later they were salted and a considerable industry sprang up for smoking these fish when they were landed.[19]

Halibut had at first been regarded by the cod fishermen as a nuisance when they caught them on the lines, and they were frequently jettisoned. Later, they began to be preserved on the ship, along with the cod, as a sort of by-product. Later still, when the product became accepted for home consumption, they were fished for specially.

In 1865, systematic halibut salting began on the Banks and there were also expeditions as far afield as the Davis Strait. In 1872, there was even a trial trip to the waters off Iceland, where the French had been complaining that halibut were interfering with the cod fishery. The fish were 'flitched', or cut into two fillets, and the fins were cut off and pickled separately. One man washed and rinsed them in tubs, and three men salted carefully in layers one above the other. A much bigger load of fish could be carried in this way, sometimes 270 hogsheads or 140,000 lb. of fish (about sixty-five tons) corresponding to 9,000 fish, and it took a correspondingly longer time to obtain a full cargo of salted than of fresh fish.

However, as in the case of the cod, salting was employed perforce, not because people had a particular liking for salted halibut, but because it was the only means of preservation available for bringing the fish back to land from distant grounds in edible condition. Smoking was employed to make the best of a bad job. When the advance of modern industry permitted the rapid transport and marketing of fresh and frozen fish, the trade in these smoked, salted halibut chunks, which amounted to more than 500 tons in 1908, declined until it has now disappeared entirely.[20]

COD SALTING AND DRYING TO-DAY

In spite of the enormous development of the market for fresh fish in the first half of the present century and the phenomenal increase in the landings of cod and related species consequent upon the growth of the north-east Atlantic Arctic fishery, mainly based upon Britain, it was nevertheless true just before World War II that the majority of the North Atlantic catch was still being preserved by the traditional methods of salting and drying.[21]

In most of the industrialized countries of the West, the liking for salt fish has declined since modern communications and the extensive use of ice permitted the distribution of fresh fish. Such salty and potently flavoured products are not now appreciated, except by a small minority. On the other hand, there is still a limited luxury market for such delicacies as pickled anchovies, and caviare, which is pickled sturgeon's roe, where a controlled process of maturation combined with salting encourages the development of specially characteristic flavours, much relished by the connoisseur.

The main outlets for the production of dried and salted cod, etc., are countries with warm climates and a relatively low standard of living.

STOCKFISH

The production of stockfish by drying in the wind and rain in a manner unchanged since the Middle Ages is still a large-scale industry in Norway, and to a much smaller extent in Iceland. The fish are beheaded and cleaned, tied in pairs by the tails and hung on a drying rack consisting of a very smoothly planed, quite heavy *longer* (pole) which rests upon stout beams.

Drying takes two to six weeks, sometimes even longer, depending on the weather conditions and the size and thickness of the fish. The final water content is about 16 per cent, which is just below the level at which mould growth is suspended. Larger fish are split up by cutting close to the bone so that they hang practically in two pieces except for a small piece of skin at the tail end, which serves to suspend the fish on the rack.[22] 'When cured, the article is a veritable club, being hard and dry and tough' said an observer in 1921.[23] It is still considered useless to land fish for the stock cure later than early April. Clear, cold frosty weather provides ideal drying conditions. If the temperature is too high, the fish goes bad before it can be dried sufficiently to preserve it. In addition, only in a certain zone of the country, north of Ålesund, can the trade be carried on for the same reasons.

Some 20,000 to 30,000 tons of stockfish are now produced annually in Norway, which corresponds to about 150,000 tons of whole cod.[24] The production of stockfish in Norway has in fact increased within recent times. In 1879, it is reported that of a catch of 24 million cod, 85 per cent was salted and only 15 per cent dried.[25] Allowing 7 lb. for the average weight of a fish, about 10,000 tons of fish would therefore have been dried as stockfish.

In the nineteen-twenties, as much of the Norwegian catch of cod was converted into stockfish as was made into salt fish, compared with only about 5,000 tons used fresh. Stockfish is now somewhat less important, and fresh and frozen fish bulk more largely in the exports of Norway. The latest figures show that the production seems to be on the increase. Most of the Norwegian stockfish is exported to Italy which took 11,000 tons out of 26,000 tons total export in 1938, and 8,250 out of 16,500 tons in 1950. It is usually soaked before retailing there. British West Africa took 8,500 tons in 1938 and 3,000 tons in 1950, Nigeria importing by far the largest quantity. Salt fish is apparently not accepted there, although there is a large demand for salt itself. *Afrikafisk* is the lowest grade of product. Higher grades are consumed at home and in Sweden, which takes about 1,500 tons a year, and are exported in smaller quantities to the United States (about 800 tons a year), chiefly for the Scandinavian element in the population. This stockfish is reconstituted by prolonged soaking in water and alkali, and is thus made into a special dish known as *lütefisk*, which is much relished by those who have acquired the taste for it.

However, it is the African market, opened up at the end of the nineteenth century, which is by far the biggest potential outlet for this type of product, and which still seems to be unsatisfied and is probably responsible for the recent tendency for stockfish production to rise.

SALTED COD AND RELATED SPECIES

However, drying alone is much less important and widespread than the salting and subsequent drying of cod and related species, such as ling, saithe, tusk and haddock. These fish are split ventrally and cleaned in precisely the same manner as has now been current for several hundreds of years. Particular care is taken to remove blood, slime and the black skin inside the 'nape'. The backbone is removed except for a few inches near the tail which is left to provide rigidity. Machines are now available which do the heading and splitting, but the human hand is still perhaps the best because it is more sensitive and instantly adaptable than a machine. The fish is then dry salted in a cool place in stacks about five feet high with layers of salt interspread between layers of fish, using thirty parts of salt to about one hundred parts of fish.[26,27] Stacking with salt (kenching) at sea is universal in Nova Scotia, and shore kenching is common in Quebec north of the St. Lawrence. The liquor extracted by osmosis is allowed to drain away as a pickle. Within fifteen to twenty-one days at ordinary temperature, the salt has generally penetrated or 'struck' through the flesh, saturating the remaining juices. The fish is restacked with the addition of more salt several times during this period. The 'green' cure then obtained is said to be lying in 'wet stack' and remains in this condition sometimes for a month or two before the finishing process of drying is commenced.

Dry salting in this manner results in a product which contains less liquor saturated with salt and therefore less salt than the 'wet pickled' cure, often of fillets, in barrels, in which the brine formed is allowed to collect until it covers the fish. The salted fish is now washed in sea or fresh water to remove loose salt, sometimes with mechanical brushes, and allowed to drain: it now contains about 56 to 58 per cent of water. Finally, it is dried to a water content of about 40 to 45 per cent, depending on the market. A typical cure for shipment to tropical areas such as Brazil will contain only about 38 per cent of water. Longer journeys and warm climates demand a lower water content.

Between periods of drying, the fish are piled six or seven feet high and are re-stacked several times so that they are all subjected to pressure. The 'sweating' also helps to even up the salt and moisture content throughout the fish. Each fish is handled somewhere between twenty and thirty times. In Canada this hard salted cod is produced chiefly in Nova Scotia, and also in the northerly part of Quebec. The Gaspé cure still survives as a more lightly salted, dried cod, which finds its principal outlet in countries with fairly temperate climates (e.g. Italy) rather than in tropical countries, where it would not keep sufficiently well. The fish after splitting are stacked with sufficient salt only to be completely dissolved after two or three days. The fish are then subjected to alternate periods of drying in the open on flakes and 'sweating' in stacks for about six weeks, until the moisture content is below 40 per cent. A softer cure containing about 50 per cent of moisture is used for cutting up to produce 'boneless fillets'. Even the fully dried product is rather perishable and is liable to a black mould growth on prolonged storage in bulk.

Natural drying in the sun and wind used to be universal, even in Britain with its changeable climate. Within quite recent memory there were large drying yards where fish were dried on wire netting racks at Aberdeen, Grimsby and Hull (at the so-called 'Cod-Farm'), and open-air drying is still continued on a small scale (*see* Plates 11–13). The fish had to be covered up when it rained and brought under cover at night when the relative humidity was high. Whereas stockfish will continue to dry to some extent under practically any atmospheric conditions, we now know that the presence of a saturated salt solution in salt fish lowers its equilibrium water vapour pressure to about 76 per cent relative humidity. Drying only occurs when the atmospheric relative humidity is below this, and is excessively slow above about 70 per cent. Above 76 per cent relative humidity, condensation of moisture actually occurs on the dry fish indefinitely, as it would on a saturated solution of common salt. Open-air drying normally took four to six weeks. Owing to the uncertainty and lack of control of natural drying, it has been increasingly replaced throughout the North Atlantic countries by various forms of artificial drying. At the simplest, coke braziers are employed to speed up the drying by inducing a draught and also raising the temperature, thus lowering the relative humidity, although at temperatures above about 90° F. the product is spoiled by being 'cooked.' Various forced draught mechanical dryers often of rather crude design and construction, are also employed. Drying still takes several days.

Mr. A. L. Wood has given the following account of some early American drying contrivances.[28]

'Even before 1878, a number of devices had been invented in North America for drying fish by artificial means, by the use of heat, dry air, absorption pads, etc., but only one came into general use. This consisted of one or more horizontally revolving wheel-like tables, having two outer rings with a bottom of network upon which to place the fish. A corresponding covering of network retained the fish during rotation of the table. The tables were in sections to allow for removal of the fish from any portion without disturbing that in any other portion. The whole was then supported by covering arms radiating from a vertical spindle, and the structure rotated, thus creating a current of air over the fish.

'Another method was introduced by Halifax parties at Gloucester in 1883. Two apartments were fitted with flakes, the floors being partly open to allow the air to circulate. By means of fans, operated by steam power, the external air was drawn in from one side of the building and out on the other side when the weather was suitable for drying. When the atmosphere was loaded with moisture, the inlet and outlet were closed and communication opened to a cooling room overhead, the temperature of which was lowered by cakes of ice. The air contained in the drying and cooling rooms was then recirculated over the fish, through the cooling room, back again over the fish, and so on. The inventor claimed the fish were "brighter and contained less dirt and dust than those dried on flakes", but the expense was considerable and consequently this process was abandoned.

'In 1890, Mr. Cathcart Thompson, of Halifax, brought to notice a process by which he claimed that codfish could be dried by absorbent pads. In its improved form this method consisted of piling layers of fish, each separated by a pad of moss and sawdust, and placing the whole under pressure by screw or lever. In the Twenty-fifth Annual Report of the Canadian Department of Marine and Fisheries it was reported that a quantity of 200 pounds of cleaned fish, put under Thompson's process after 312 hours, gave a weight loss of 36 per cent.

'It is significant that up to this time little mention is made of using heat in the drying process. However, in 1892 Mr. Thomas S. Whitman, of Annapolis, N.S., patented a process by which salt fish was washed, pressed for a few hours, then spread on wire flakes contained in compartments traversed by pipes in which steam or hot water was permitted to circulate. After the fish was warmed, currents of cool, dry air were forced over and under the fish on these flakes for two or three hours. By alternately heating and cooling the fish, between one and two per cent of moisture per hour was removed from the fish. The products of evaporation were carried from the compartments through suitable ventilators in the roof.

'The first practical working model of the Whitman process was installed at Annapolis, N.S., where, in four years' operation, it produced from 10,000 to 15,000 quintals of dried fish annually. Subsequent installations were made at Halifax, Lunenburg, Liverpool, in Nova Scotia; Paspebiac, Quebec; and Gloucester, Mass. Drying costs are reported as 30 to 35 cents per quintal for fish suitable for the West Indies, 40 to 45 cents for Central America and 45 to 50 cents for Southern Brazil.

'By 1925, the large firms in Halifax and Lunenburg had artificial dryers, in which either the Whitman process was employed, or a current of heated air was passed over fish on flakes. Either hot air, hot water or steam boilers were used, together with electrically driven fans. Some of these dryers carried the fish through on cars or trucks. Many claims have been made that these dryers were capable of drying fish from the "green" or wet state. However, it is known that they were definitely successful in finishing fish which had received one or two days' "sun drying".

'The chief criticism of those dryers in operation in 1936 was their inefficiency, and the difficulty in controlling temperatures to within reasonable limits. Optimum temperature, relative humidity and air velocity had not been definitely established and dehumidification of the inlet air had received little attention.'

At about this time, the Atlantic Fisheries Experimental Station at Halifax, Nova Scotia, undertook a complete study of the subject of drying heavily salted fish. Newfoundland and Norwegian research workers have also made definite contributions to the establishment of optimum drying conditions within the last twenty years or so.

Scientific research has led to a better understanding of the drying process, hitherto controlled largely by 'rule-of-the-thumb' methods. According to the latest Canadian data, the optimum air velocity over the fish should be between 200 and 300 ft. per minute. Slower velocities decrease the rate of drying, whilst faster velocities do not increase it significantly, and merely add to power costs. The air temperature should be between 60° F. and 80° F. (16° and 27° C.) and preferably about 75° F. (24° C.). The relative humidity of the air in the dryer should be between 45 and 55 per cent; above or below this drying is slower. Slow drying at the beginning results in the formation of undesirably rough and pebbly crystals of salt on the surface. Under the optimum conditions specified, the rate of drying decreases steadily for the first six to ten hours. By this time the surface has dried to form a salt crust and drying then proceeds at a constant rate by evaporation underneath the surface. Stacking at this stage wets the crust so that the rate of drying is increased until the surface layer is reformed. In this way, it is claimed, hard dried salt cod for export can be produced in about forty hours. Over a hundred dryers of a type designed to reproduce the above conditions, holding 1,500 to 2,000 lb. of 'green' salt fish, have been installed in Canada. Some plants during the summer months 'dehumidify' the air used for drying. However, at least one plant in Canada was still, in 1946, operating a dryer built to the original Whitman patents.

There is about 45 per cent reduction in weight in heading, cleaning, and splitting, of which the head alone accounts for about 20 per cent and intestines 15 per cent in the case of ungutted fish. The yield of wet salted fish is about 40 per cent and of dried salted fish about 30 per cent of the weight of the ungutted fish.

Dried salted cod, and wet pickled cod, keep in satisfactory condition at ordinary temperatures of 50° to 60° F. (10° to 15° C.) for about four to six months, but salted cod in 'wet stack' keeps in good condition for only about two to three months, after which 'pink' spoilage sets in. This results from the growth and activity of aerobic (requiring air), halophilic (salt-loving) bacteria which cover the flesh with a pink slime; and by attacking the proteins, soften the fish and cause it to give off objectionable odours. The organisms responsible are now known to occur in the salt itself, particularly in 'solar salts' made by the natural evaporation of sea-water. Heat-sterilized salts are now available, but it is useless relying on these in a building which is already infected. Once the organisms have infested a curing shed, there is little that can be done to disinfect the premises short of burning them down. However, they cannot multiply in dry conditions, so that prompt drying prevents spoilage. In addition, proliferation is arrested at temperatures below about 40° F. (4° C.), at which all forms of salt fish, including 'wet stack', keep in excellent condition for about a year. Salt cod is still by far the most important item of international trade in fish, in which most of the maritime nations of the North Atlantic have a stake (*see* Table 2).

For the best and whitest product, the fish should be bled at sea immediately it is caught. This procedure is only possible with a hook and line fishing such as that of Norway. In Norway, Iceland, and Canada, there is strict government inspection of salted fish intended for export. In Norway, the industry itself exercises a measure of self-control through its own laboratory at Kristiansund N.

Britain relies for its supplies for salting mostly on some of the poorer long-distance trawled fish. Even before the first World War, German trawlers landing from Icelandic grounds, chiefly supplied Aberdeen with fish for salting. In Hull, the salt fish industry started in 1897, using the same class of raw material. Britain therefore cannot hope to make the best grade of product. However, considerable quantities (5,800 tons in 1951) are imported from the Faroe Islands and Iceland in the 'wet-stacked' condition for drying in Britain. France and Portugal operate fleets of vessels—including trawlers over 200 ft. in length— that salt at sea, particularly on the Grand Bank of Newfoundland. British firms have tried this occasionally even on the Arctic fishing grounds. A recent attempt by Hull trawlers was abandoned because of the fish becoming discoloured in wet stack aboard the ship. An excessively high iron content in the salt

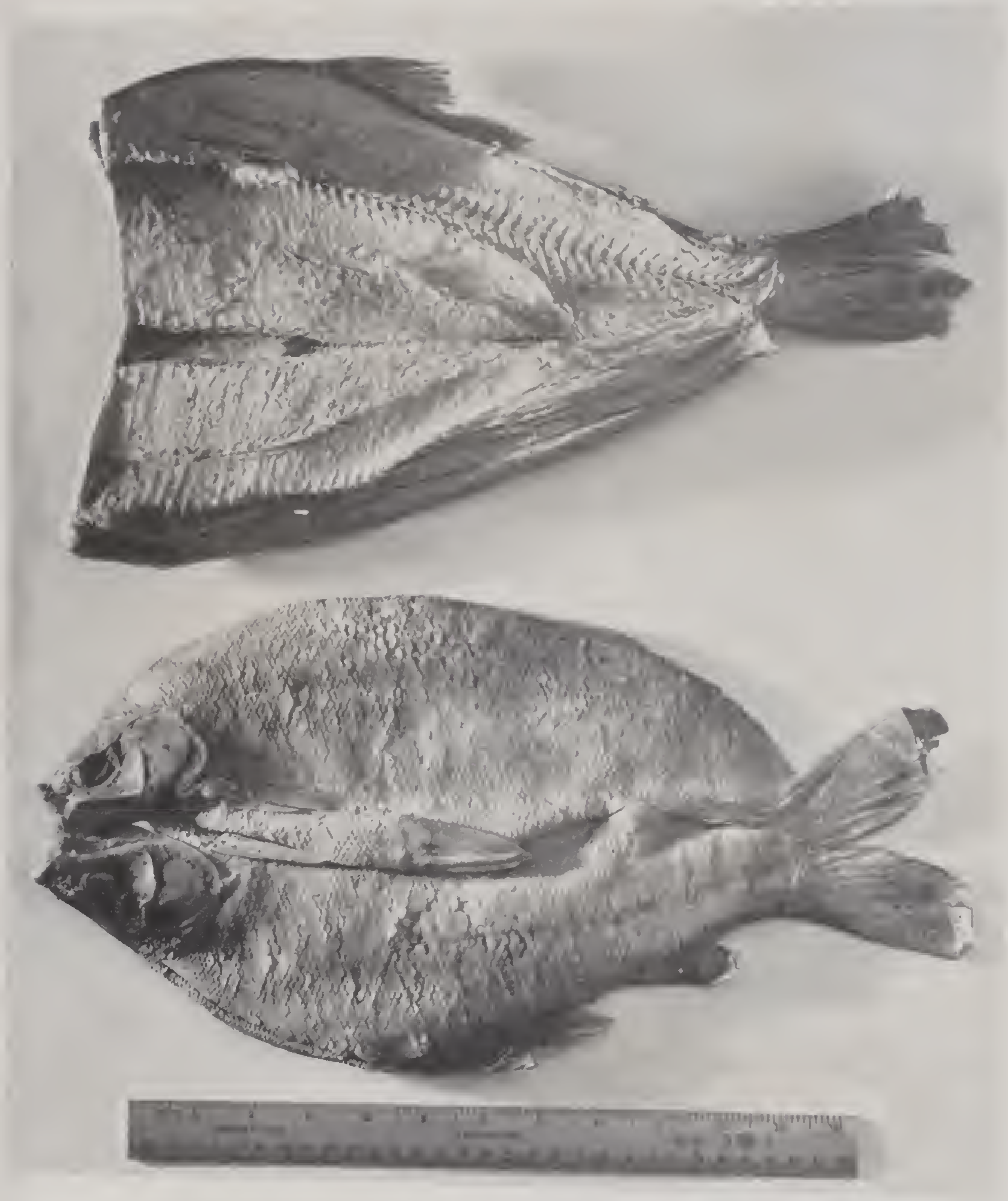


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Plate 14.—Salted *Tilapia* from East Africa.

TABLE 2 APPROXIMATE ANNUAL PRODUCTION AND DISPOSITION OF SALT COD, 1920–39 (Thousands of tons)

		Producing country							*Home production*
		Newfoundland	*Iceland*	*Norway*	*France*	*Canada*	*U.K.*	*Faroe Is.*	
Total production	258.8	65.2	50.1	42.2	38.0	25.3	13.1	13.0	10.4
Importing country	Total imports								
Europe									
Spain	57.3	12.2	19.8	10.1	2.6	0.3	4.3	7.4	2.8
Portugal	39.8	10.9	6.3	15.3	1.5	0.2	3.3	1.2	4.9
Italy	38.5	7.3	14.3	1.9	6.6	2.3	0.8	4.2	—
Greece	9.4	3.3	0.2	0.2	3.7	1.4	1.0	0.4	—
France	1.3	—	—	—	—	—	—	—	—
Total†	—	53%	98%	69%	—	12%	—	99%	—
S. *America*									
Brazil	26.8	11.7	0.1	0.5	0.2	1.7	7.6	—	—
Argentina	4.7	—	0.1	3.4	—	—	1.1	—	—
Total†	—	19%	2%	19%	—	10%	—	—	—
Caribbean									
Cuba	13.3	0.2	0.2	4.0	—	5.3	0.9	—	—
Dominican Republic	1.7	—	—	—	—	—	—	—	—
Total†	—	24%	1%	10%	—	55%	—	1%	—
N. America U.S.A.	19.4	5.4*	0.1	4.3	0.2	1.7	7.6	—	2.5
Total†	—	2%*	—	1%	—	23%	—	—	—
Others	19.7	2%†	—	1%†	—	—	—	—	—
TOTAL	231.7								

* Inconsistency reflecting conflicting data in Tables A-23 (p. 142) and A-36 (p. 157) of the publication by Gerhardsen and Gertenbach[21] for exports of dried salt fish from Newfoundland to the United States possibly produced by inclusion of Labrador with Newfoundland in some places.

† Percentage of country's production going to importing area.

produces this effect, but it does not explain this particular occurrence which seemed in some way to be associated with minute traces of copper in the salt used. The presence of calcium and magnesium salts as impurities in the salt always tends to give a whiter product than pure sodium chloride.[32] The reason for this seems to be that the precipitation of protein caused by the impurities results in greater opacity; in addition, the rate of penetration of impure salt is slower; excessive impurities also produce bitterness to the palate.

The principal consumers of dried salted cod are the Mediterranean countries, South America, and the Caribbean. Before 1914, the cod caught in the North Atlantic was almost entirely salted; in 1920 the proportion was 85 per cent, while in 1938 only about one half was preserved in this way. Nevertheless the volume of trade has remained remarkably constant. The decline in the proportion of the total catch used for salting is accounted for by the increased catch of trawlers from the northern waters which is mostly consumed in the 'fresh' state. The proportion of the total landings of related species, such as saithe and ling, which is salted, is very much less than in the case of cod. However, the characteristic 'cured' flavour produced by the action of micro-organisms and enzymes during the protracted drying, and the toughness of the traditional products, as well as the excessive saltiness of salt cod, combine to make the traditional products unacceptable to most western palates, which are now mostly accustomed to blander flavours.

Salt cod was until recently a customary Sunday dish amongst working-class families in Liverpool. It is also eaten occasionally by the older generation in fishing ports where the custom has not completely died out. In Aberdeen it is still known colloquially as 'hairy Wullie' (Willie), presumably from the rather fibrous appearance it has after desalting and boiling. However, the large quantities imported in the wet salted state from Iceland during the war, met with anything but ready acceptance by the general population, whether sold wet or smoked after desalting. Nevertheless, the world production of salted cod shows at present no tendency to fall, rather the reverse. 1950 production was about 320,000 tons, which is a good deal higher than in 1938, and the estimate for 1952 was higher still.[33] That for 1953, although lower, was still above pre-war.

FISH SALTING AND DRYING OUTSIDE THE ATLANTIC AREA

Smoking and drying is still one of the chief methods of preserving fish throughout the world, especially in Asia and Africa, where in coastal areas and on suitable rivers and lakes, much fish is landed *in toto*, and mostly preserved by primitive processes, involving combinations of sun-drying, hot-smoking and salting. Japan, by far the largest fish-producing country in the world, consumes much of its own production in various dried, salted and smoked forms. Its normal consumption has been estimated at between 300,000 and 400,000 tons of hard-smoked and salted fish, including a great deal of salmon, which corresponds in amount to perhaps about a million tons of fresh fish. The forms in which fish are preserved for food are various.[35] Cuttle fish, shark fin, herring and herring roe, not to mention *Laminaria* (a seaweed) are dried without salt. Sardine, horse-mackerel, mackerel and cod, are salted and dried. Sardine, again, and shrimp, are cooked by steaming and then dried. Salmon, trout and herring are smoked; bonito, mackerel and tuna are steamed, smoked, and then dried. In addition, edible fish meals are prepared from sardine and herring as well as white, non-oily fish such as cod and flat fishes. Oily fish, such as sardine, herring, mackerel, yellow tail, salmon and trout are also preserved by salting alone. Finally, there is a good deal of manufacture of fish pastes, typical of the Far East, by mincing up sardine, mackerel, cuttle fish, etc. with various spices and salt and vinegar, etc.

China and south-east Asia[36] are also large fish producers, relying mostly on similar methods of preservation. Indo-China in particular[37] has developed types of fish sauce, e.g., *nuoc mam* and *nam pla* in which salt plays an essential rôle by inhibiting bacteria while the enzymes are permitted to digest the fish by autolysis until it is liquid. Very often the fish is buried in the ground in an air-tight container for some months. The autolysate, which contains 30 to 40 per cent solids, including salt and amino acids, etc., when filtered from the bones which do not dissolve, can have rather an attractive flavour reminiscent of shrimp essence, but an enormous variety and quality of product is produced in this manner. Prior to 1939, Singapore was a particularly important market for salted fish from the salteries of Malaya, consuming some and re-exporting the remainder. Large quantities were also imported from Indo-China and Thailand[38] and the exports went to Indonesia, Burma and Sarawak, as well as Malaya. Imports used to amount to between 45,000 and 50,000 tons annually, excluding about 20,000 tons from Malaya itself. Re-exports, too, were in the neighbourhood of 50,000 tons, excluding about 12,000 tons to Malaya. Post-war dislocations have caused this trade to decline. Imports from all over, including Malaya, declined from 18,000 tons in 1947 to 9,000 in 1949 and exports from 13,000 tons in 1947 to 7,000 in 1949. The details of the methods of fish preservation used in this area—which produces nearly half the world's fish—are scattered in various accounts. Recently a useful handbook has been compiled, however, of the processes employed in the Republic of the Philippines.[39]

India, in spite of its enormous population, is not proportionately a large fish-eating country. Nevertheless, about 250,000 tons of fish are sun-dried or salted there annually. Smoked fish is relatively unknown. Salt has always come under Government control and improved salting facilities are being steadily provided.

In the Red Sea area, sharks are salted and dried. Along the coasts of Arabia, small fish such as anchovies are sun-dried on the sand, as they have always been (*see* p.49) and exported as animal fodder.

In Africa, salted fish is not generally liked, although in both British East Africa (*see* Plate 14) and French West Africa, attempts are being made to establish salt curing industries.[40, 41] Native reliance is placed chiefly on various primitive methods of drying in the sun or over fires in which the fish are cooked and smoked at the same time, as is the case with the Gold Coast *bonga*, a species of shad (*Ethmalosa*), about the size of horse mackerel with a fairly low fat content of about 3 or 4 per cent, for sale in inland markets. To prevent the fish from going bad in the early stages of preservation, so much initial heat must be applied that the fish are partly roasted and sometimes charred and blackened although at times the product is surprisingly palatable even when eaten in the dried state without further cooking.[42, 43] This native dried fish will remain edible (to African tastes) for from a few days to a few weeks, even a month or two in very favourable circumstances since in order to maintain the fish in edible condition for as long as possible, it is frequently re-smoked and dried from time to time. In Sudan, small fatty fish about the size of sprats taken from the Nile are slightly salted and transported in used petrol tins. The condition of the product, known as *fazeeq*, is normally such that a small hole must be punched in the top of the tin, otherwise the gases generated during the putrefaction which ensues after closing would burst the tin.

The efforts now being made throughout most of the areas mentioned to improve native methods of preservation are described in Chapter 13 (*see* p. 332).

Finally, there are areas of intermediate economic status where the counterparts of the European salted and dried products are already in production. Venezuela is such a case,[44] and South America has long imported Atlantic dried-salted cod for its *bacalao* dish. Local species are now being salted and dried, largely as a result of the work and advice of United States workers who have studied the problems of preserving fish in warm climates.[45,46]

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Chapter 8

THE CANNING OF FISH

The canning of fish has played no small part in the economic and technological development of the canning industry, and several types of canned fish are now almost as much standard items in the diet of some people as pickled herring and dried-salt cod would have been in former times.

Canning is a classic example of a new food process being consciously evolved to meet new needs, viz. to supply Napoleon's huge citizen armies with fresh food or something akin to it. Marlborough's army at Blenheim in 1704 numbered only 54,000 men, who could almost live off the land. Napoleon invaded Russia in 1811 with over a million, and a highly organized food commissariat was required.

In 1795, the revolutionary French Directory offered a prize of 12,000 francs for a new method of preservation which would retain more of the original characteristics of the fresh food. Nicholas Appert (1752–1841) who worked from 1795 till 1804 before getting much success, was awarded the prize in 1809: he published his results in 1810. His method consisted of cooking the food in glass containers, and then sealing while hot (*see* pp. 5 and 9).[1] Appert's book *Le Livre de tous les Ménages ou l'Art de Conserver pendant Plusieurs Années Toutes les Substances Animales et Végétales*, was soon translated into English, and appeared in 1811 under its literal title *The Book for All Households, or the Art of Preserving Animal and Vegetable Substances for Many Years*, published by Black, Perry and Kingsbury of London.[2] A second edition appeared in 1812 and the first U.S. edition, prepared from this, was published in New York in the same year. In 1814, Appert was delivering to the French Government, amongst other things, fish and lobsters preserved according to his method. He visited London in the same year but appeared to arouse no great interest. In fact, even before this visit, his methods were being applied by others. A writer in the *Edinburgh*

Review of April 1814, quoted by Bitting[3] fully envisages the possibilities and looks forward to having salmon, mullet and turbot at all seasons and in spite of climate or game laws.

It was the use of iron containers plated with tin to protect against corrosion that permitted the large-scale development of this form of preservation. Tinned-iron containers had been used for some time previously for packing salt fish, smoked salmon, etc. (*see* p. 86).

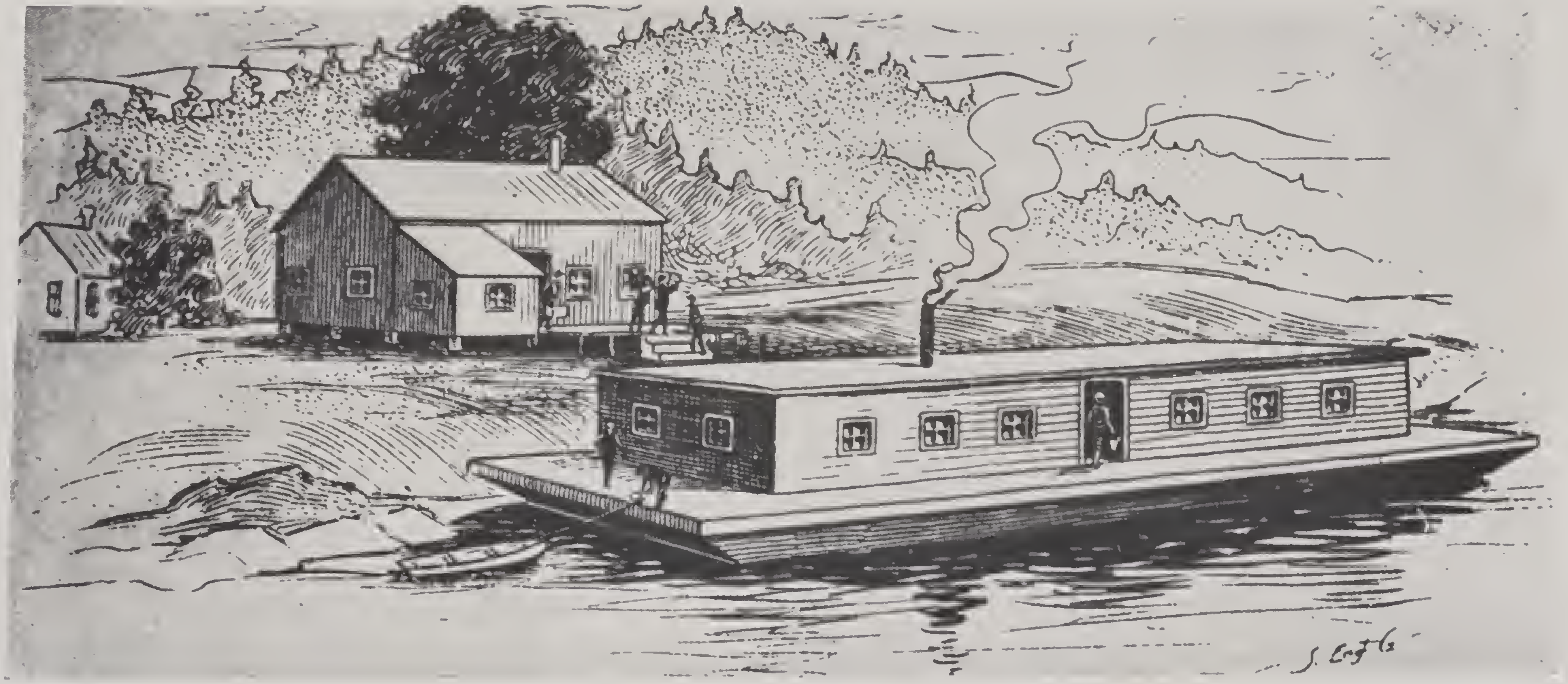
The use of tinplate containers for preserving foods in the new fashion was patented by Peter Durand in 1810, although scarcely adopted until 1820, and in 1823 a patent introduced the sanitary can with soldered-on lid containing a small hole for the escape of air and steam, which was soldered up after cooking (i.e. 'exhausting').

EARLY BRITISH FISH CANNERS

With the advent of canning we enter an era in which names and dates associated with new developments are fully documented. It was John Hall, founder of the firm of J. & E. Hall, and Bryan Donkin, F.R.S., who were the first in Britain to preserve successfully by the new process on a commercial scale, although they were mostly concerned with meat.[4] It was not many years, however, before they were facing competition, particularly from Scotland. In Aberdeen, John Moir (1766–1833) who appears to have come from Leith, began canning about 1822, and Hogarth and Dickson in 1824–5; while in Glasgow, Æneas Morison started in 1824. Moir supplied Cooper of London with some of the victuals for the expedition of the explorer, Parry, in 1824. He wrote to Cooper on 21st June, 1827: 'Salmon still continues very scarce . . . The lowest price I can sell you lobsters is 1*s.* 6*d.* for pint cases and 10*d.* for half pints.' The following extracts from his letter book, reproduced recently by Dr. and Mrs. Clow,[5] show that he was canning mostly salmon, grilse, trout and crabs:

Mr. John MacDonald, Aberdeen, Dr. to John Moir

1825			s.	d.
July	15	To 1 Grilse, 6 lbs. @ 6d.	3.	–.
Aug.	2	,, 1 ,, 5 ,, @ 6d.	2.	6.
	8	,, 1 ,, 5 ,, @ 6d.	2.	6.



By courtesy of the Editor, Pacific Fisherman, *Portland. Oregon. U.S.A.*

PLATE 15.—Humes' first salmon canning factory on Sacramento River, California, 1864.

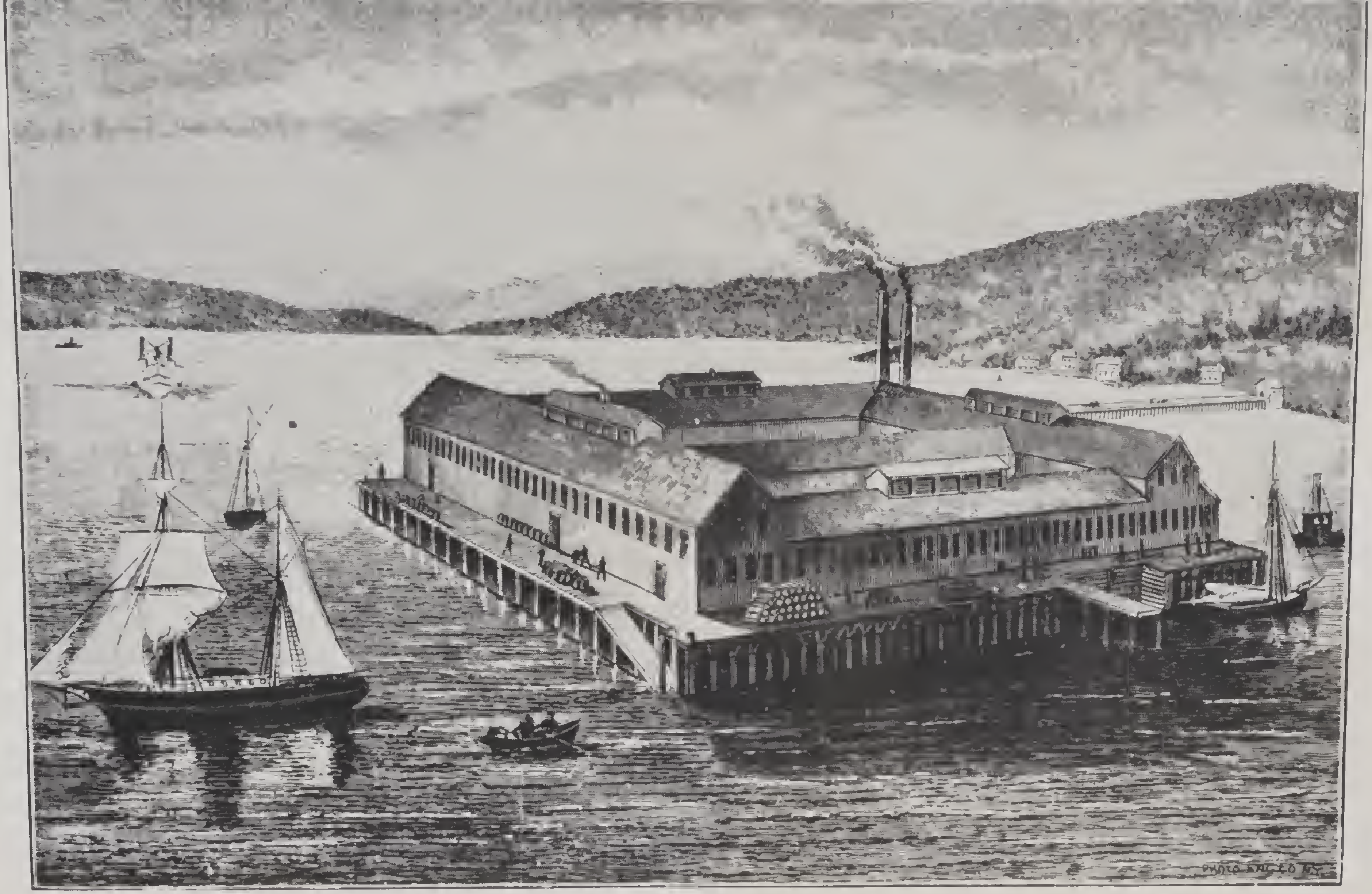


PHOTO ENG. CO. N.Y.

By courtesy of the Government Printing Office, Washington, D.C., U.S.A.

Plate 16.—Pacific Salmon Cannery (about 1880). *From* The Fisheries and Fishery Industries of the United States *by G. Brown Goode* (1884).

July	9	To 3 Grilse, 3 lbs. heads @ 2d.	–.	6.
	18	,, 1 ,, 3½,, @ 6d.	1.	9.
	22	,, 1 ,, 7 ,, @ 7d.	4.	1.
Aug.	1	,, 2 ,, 13 ,, @ 7d.	7.	7.
1826				
April	26	To 7 Pints preserved crabs @ 1/-	7.	–.
Aug.	3	,, 1 Grilse 3½ lbs. @ 6d.	1.	9.
	13	,, 1 Case preserved salmon @ 1/6	6.	–.
		,, 1 Grilse, 3½ lbs. @ 6d.	1.	9.
	15	,, 1 Pint preserved crabs @ 1/-	1.	–.
	17	,, 1 Grilse 7½ lbs. @ 7d.	4.	4½.
	28	,, 1 Cut salmon 6 lbs. @ 1/-	6.	–.
	22	,, 1 Case salmon 4 lbs. @ 1/6.	6.	–.
	31	,, 1 Grilse 6½ lbs. @ 7d.	3	9½.
Sept.	6	,, 4 lbs. Trout @ 3d.	1.	–.
Nov.	10	,, 1 Pint crabs @ 1/-	1.	–.
1827				
Feb.	1	To solder for closing the seams and putting on the rings of 149 doz. 4 lb. cases at 1 oz. per dozen; 9 lbs. 5 oz. @ 9d.	6	11½.

Meat packed in a lobster sauce is also mentioned. Hogarth gave important evidence before a Government inquiry in 1852 when the British canning industry had run into trouble. Large consignments of canned meat to the Admiralty for ships at sea had gone bad. Although not understood at the time, it was undoubtedly caused by imperfect sterilization of excessively large cans in which heat penetration to the centre was extremely slow. At the inquiry, Hogarth claimed to have been using steam under pressure for sterilising his products since 1837, thereby maintaining a much higher temperature than could be obtained by boiling water (and consequently, as we know now, a quicker and more complete destruction of micro-organisms in the can). Others credited with the early use of water and steam under pressure are Fastier (1839) and Isaac Winslow (1843).

This method must have been difficult to control at that time, which was apparently forty years before the patents of Schriver and Phibb. An easier way of obtaining temperatures higher than that of boiling water was to add various salts to the bath.

The English are said to have been the first to use common salt (sodium chloride) for this purpose. Other salts such as saltpetre (sodium nitrate) or calcium chloride gave even higher temperatures. With the latter—which was patented independently by Stephen Goldner and John Wertheimer in 1841—boiling points of 270° to 280° F. (132° to 138° C.) could be obtained. The French are supposed to have started using salt and calcium chloride about 1850. Owing to the high pressure generated inside the cans at these high temperatures, a fair proportion of them burst during processing.

THE BEGINNINGS OF CANNING IN THE U.S.A.

Although canning has now come to be regarded as a characteristically American industry, the pioneers were, not unnaturally, English immigrants. Moreover, 'nearly all the pioneer factories started on fishery products as the primary pack.' William Underwood, who had had experience of pickling in England, arrived in the South in 1817 and started preserving after the manner of Appert in Boston a few years later. The products, including lobsters and salmon, were mostly exported, under a label 'Made in England'.[7] Presumably the omission of 'New' was deliberate. Thomas Kensett, also from Britain, had been preserving sea-foods, including lobsters, in New York City since 1819, along with his father-in-law, Ezra Daggett. Later they moved to Baltimore, chiefly to preserve oysters taken from Chesapeake Bay. Both these pioneer firms relied on boiling water and glass jars.

In 1818, Peter Durand had taken out an American patent, eight years after his British patent, for his 'tin canister', named after the Greek word κάναστρον, meaning a basket of reeds, commonly used for holding tea, coffee, fruits, and vegetables in early nineteenth-century England. Although Kensett and Daggett were granted a patent in 1825 for 'an improvement in the art of preserving', using 'vessels of tin', it was not until 1839 that they and Underwood both adopted 'tins', which were cheaper and less liable to breakage than glass containers. They had to be made by hand-cutting sheets of tinplate with shears, bending and soldering all round, and sixty canisters was a good day's production even for an expert. It was Underwood's bookkeepers who first coined the abbreviation 'can'.

In 1840, Tristram Halliday was canning Atlantic salmon and lobsters on the Bay of Fundy at St. John, New Brunswick. Treat studied there before canning lobster and salmon at Eastport, Maine, which soon became a great sea-food canning centre, with streets named after canners.

For a time the Americans were rather slow in hearing about and adopting technical advances. Thus sterilization was carried out in a water bath, sometimes with salt added to raise the boiling point to about 230° F. (110° C.). Isaac Solomons at Baltimore in 1861 first added calcium chloride to raise the boiling point to 240° F. (115° C.) allowing sterilization times to be reduced from as much as six hours to between twenty-five and forty minutes while the output of his cannery was increased from 2,500 to 20,000 cans per day. Although Raymond Chevalier-Appert, who managed the original French canning firm from 1846 to 1869, had devised an autoclave with manometer in 1852, it was not until 1874 that A. K. Schriver of Baltimore patented the steam kettle for use with superheated water or live steam, which was the forerunner of the present form of retort. This prevented bursting by maintaining a pressure outside the can as well as inside.

The production of the open-topped, pressed-out, sanitary can, also an arrival from Europe, was worked out by Max Ams between 1890 and 1893. The pace of mechanization had now been accelerated so that by the turn of the century, America was the acknowledged leader in canning efficiency.

CANNED SALMON

Although salmon was canned on a small, almost domestic, scale at Aberdeen, Scotland, in the eighteen-twenties, Crosse and Blackwell's, still a well-known British firm, have been credited with establishing the world's first salmon cannery at Cork, in the south of Ireland, in 1849. However, apart from isolated instances on the Atlantic coast of North America, it was the teeming rivers of the Pacific side of the Continent that were to supply the main impetus to the canning of fish. The first big increase in demand for canned fish came with the Civil War (1861–65).[8]

It was in 1864 that three brothers, Hume, men of Maine of Scottish descent, and Hapgood who had had experience of canning lobsters and salmon in Canada on Chaleur Bay, first started canning Pacific salmon on the Sacramento River, in California (*see* Plate 15). Hapgood's complete canning machinery consisted of a screw hand-press; sets of iron dies for making can tops and bottoms; a pair of squaring shears to cut out the bodies and one pair each of rotary shears for cutting the round ends, bench shears and snips; a pair of 24-in. rolls for making the bodies cylindrical; an anvil weighing 50 lb.; a forging hammer and a tinner's hammer; a set of punches, a riveting set and a grooving set; two iron seals with grooves in which to mould strips of solder; an iron clamp to hold the bodies while their seams were soldered; and a triangular piece of iron to assist in holding the bodies. They sterilized in salt water in an iron kettle on a brick furnace fired by hand. After one hour of boiling and testing with a thermometer, the cans which had not exploded were cooled in a sheet-iron pan. After washing they were painted with a handy mixture of red lead, turpentine and linseed oil. Fiery red paint thereafter denoted red salmon and it was a long time before canned salmon could be sold without a red label.

In 1865, fewer fish came up the river, probably as a result of contamination by effluent from the cities and gold mines established after '49.

In 1866, therefore, they moved their equipment northwards to the Columbia River and canned 6,000 cases of forty-eight 1 lb. cans each at the old fur town of Astoria.[9] Others followed the Humes and Hapgood and by 1876 from these beginnings, 450,000 cases of various species of Pacific salmon, chiefly chinook, were packed for export to England and Germany as well as the home market (*see* Plate 16). The canners pushed northwards to the Fraser River (1867), Puget Sound (1877) and the coast line of British Columbia and Alaska (1878) as far as Bristol Bay and the Aleutian Islands. It was possible to establish large-scale industries at these places because, unlike the situation at Aberdeen, there was an enormous surplus of supply over demand for the fresh market and for curing.

By 1880, the exportation of canned salmon from the Pacific Coast, which was double that in 1875, exceeded 257,000 cases (about 5,000 tons) a year, of which half went to England, a quarter to the Continent and the rest to New York, etc., in addition to 3,000 tons consumed in California. The English consumption of imported canned salmon was therefore already nearly as high as that of fresh, viz. 3,600 tons home caught, which was supplemented by 150 tons imported from Norway.

Alaska is now the most important area and canning is there practically the only outlet for salmon. From 8,159 cases in 1878, the Alaskan pack reached 2,400,000 cases in 1910 and 8,500,000 by 1936. This enormous increase in production was made possible only by thorough-going mechanization, notably by means of the 'Iron Chink' invented in 1903 by E. A. Smith of Bellingham, in the State of Washington, to replace the Chinese labour hitherto engaged in the butchering and cleaning of the salmon prior to canning. This handled fish at the rate of sixty per minute, later increased to eighty per minute. According to Bitting, the 'Iron Chink' is 'one of the ten outstanding inventions in the canning industry.'

Another useful development was the collapsed can in 1910. This permitted efficient centralized manufacture of bodies, which were flattened for transport and assembled and formed at the canning factory, as required. Three hundred and sixty bodies and bottoms could be packed into a case normally holding forty-eight empty pre-formed cans.

Salmon canning industries were established in Japan in 1890 and Siberia in 1906. In 1936 the total world output of canned salmon was 300,000 tons net, although in recent years it has been considerably less. The pack of U.S.A., by far the chief packer, has fallen by nearly one half from 160,000 tons in 1938 to 90,000 in 1950.[10]

Typical procedure at a salmon cannery in Alaska, the Pacific coast of Canada and the northern part of the United States is as follows. The five species of salmon canned are first sorted out in the boats which deliver them to the canneries, and the fish are unloaded by elevators and 'flumed', i.e. transported by running water in shallow troughs to bins, from which they pass to the operators of the 'Iron Chinks', as they are still called, which gut and dress the fish, removing head, tail and fins. They are then finally cleaned by hand, carefully to avoid damaging the fish, and fitted head to tail on to the feeding conveyor of the can-filling machine, which cuts the roll into steaks of the same thickness as the can depth and presses them into the cans by means of pistons. Salt is added automatically and the cans are weighed, vacuum seamed, washed and finally retorted for 90 minutes at 250° F. (126° C.) corresponding to a steam pressure of 20 lb. per sq. in.

SARDINES

The preservation of sardines on a small scale by Appert's method was first established in France in the early eighteen-twenties, and along with salmon has since grown to be one of the two principal world fish packs.

'Sardines', or young pilchards, were so-called from being caught off the coast of Sardinia at times when the tunny sought for there was not available. Traditionally they were mostly preserved by salting and pressing in casks in the same manner as the Cornish pilchards, or else smoke-cured like red herrings. For local consumption on the coasts of Brittany they were preserved with butter, oil, or vinegar in large stone jars which were then tightly sealed. These were the forms which were first adopted for canning.

On 8th June, 1822 the *Journal de Nantes et de la Loire-Inférieure* reported that a Capt. Freycinet, who had returned from a voyage of circumnavigation on which he had taken some *conserves Appert*, had declared that: 'Elles ont supporté parfaitment et au delà de mes espérances toutes les épreuves auxquelles je les ai sourmises depuis 30 mois de navigation.'[11] These samples had apparently included some *sardines au beurre, à l'huile* canned and sent to Paris by Joseph Colin (1785–1848), a confectioner of Nantes. For canning in tinplate, olive oil was soon found to be much superior to butter or vinegar. About a hundred fish were packed in soldered, parallelepipedal boxes.

So successful did the trade become that in 1830, a restaurant keeper, Millet, went into business producing canned sardines in the centre of Nantes. There were protests from the neighbourhood and as a result of an official inquiry it was decided on 29th August, 1835, 'que la préparation en grand des sardines au beurre ou à l'huile sera rangée dans la 2^{e} classe des établissements insalubres et incommodes.' Another firm engaged in the preparation of salted provisions for shipping went into production in 1833.

In 1836, Colin's production was 100,000 cans, about one-third of which was made up of sardines. It was worth 600,000 francs, and amounted to five-sixths of the total output of canned products of Nantes. In 1840, he handed over to his son-in-law, Jules Bonhomme, but the joint firm did not prosper and was declared bankrupt on 16th September, 1843. Colin's original factory was acquired as a canning museum in 1924, but was destroyed in the allied bombardment of Nantes in September, 1943.

Similar developments were occurring elsewhere in Brittany. In L'Orient in 1825, A. M. Blanchard is reported to have been experimenting in canning. Factories were opened at Les Sables d'Olonne in 1832, Belle-Île-en-Mer in 1834, La Turballe in 1841, and Concarneau in 1840.

By 1870, there were still not more than thirty factories, all relatively small, on the coast of Brittany, but after this followed a rapid expansion of production. By 1880, it was reported that 50 million tins of sardines were being packed annually on the west coast of France, 3 million of which were exported to Britain.[12] It was soon found that the raw fish stuck together and became mushy when cooked in the can, and that it was preferable to dry and cook the fish before canning. After heading and eviscerating, the fish were washed, brined, packed tail upwards on special trays (called 'grils') consisting of an assembly of tinned iron rods forming a series of inclined planes on which about fifty fish rested. These were placed in long hand-barrows and the fish dried slightly on the surface, either in the sun when it was fine, or by artificial heat over a red charcoal fire, or in special brick kilns. The fish were next fried by dipping the trays in very hot olive oil in pans often heated over naked flames. This drove off more water. The oil was allowed to drain off, the fish were again dried a little in the sun or by artificial heat. After this, they were packed in tins, with hot oil, best quality olive oil being preferred, seamed up and sterilized.

French sardines went all over the civilized world, and became a regular 'stand-by' in the outposts where conditions were rough, e.g. in America. Thus, 'a box of sardines' is a fairly frequent purchase in W. H. Hudson's *Purple Land* (1885), depicting the life of the ranchers in Argentine.

The Breton sardine was notoriously irregular, even for a pelagic species, the fish sometimes forsaking the coast for ten years at a time. Under pressure of such a dearth commencing in 1880, the canners installed factories in Portugal about 1885, later, on the Basque coast, and later still in Morocco. Again between 1888 and 1901 there was a further expansion of the industry followed once again by a slump when the fish deserted the usual seasonal haunts. These ups and downs led to 'labour troubles'; thus, there was a strike of solderers at Concarneau in 1909.[13]

More recently cheaper, lower-grade packs of sardines have been produced with arachis (groundnut) oil, and by mechanical cooking in steam or hot air prior to exhausting the air, seaming, and sterilizing. This permits the handling of much greater quantities.

Safi in Morocco is now the most important sardine port in the world. In twenty-five years its catch has increased from 3,000 tons to 100,000 tons and there are now 181 factories in operation. The production in 1950 was between 2 and 2½ million cases (of one hundred tins of 'chub' size) of sardines, tunny, etc.

The Norwegian process of smoking before canning (now used in Britain—*see* Plates 17–19) was originated in 1879, when a firm in Stavanger combined the process of hot smoking of sprats (*brisling*) in the German fashion (*Kielersprotten*) with that of hermetically sealing in tins with olive oil.[14] Immature herrings (*sild*) are also treated in this way, but their flavour is not improved by maturation in the can in the same way as that of brisling. The Norwegian fishermen keep these fish alive, 'penned' in the nets, to empty their intestines and keep them fresh until required. The Cornish fishermen used to impound pilchards similarly.

As a result of a famous law case, Norwegian brisling may not be labelled in the U.K. as 'sardines', which is the name reserved for the immature fish of the pilchard species.

CANNING OF SHELLFISH AND CRUSTACEANS

As already mentioned, lobsters had been canned from time to time by several of the early pioneer canners. Charles Mitchell, a Scot, formerly a partner of Underwood in 1820 at Boston, packed them at Eastport, Maine, in 1840. Since they were a luxury species that commanded a high price, there was every incentive to exploit them assiduously. Unfortunately, unlike the Pacific coast salmon, supplies were soon found to be exhaustible.

According to Bitting, lobster 'was the first product to be canned on such a scale as to practically exhaust the supply in New England waters and greatly deplete those of Canada.'[3]

Oysters, too, had been canned at Baltimore by Edward Wright in 1838 and Kensett about 1841, and by Underwood at Boston in 1850. According to Jarvis, canned oyster 'was the first canned product to receive wide distribution.'[8] The canning of oysters was first attempted in Florida in 1856. Better success attended further trials in 1884, with Brunswick, in Georgia, following a little later. Artificial cultivation commenced in 1905, using large Japanese oysters in Puget Sound, first canned in 1931. The pre-war total pack was about 500,000 cans per year. Crab meat, also, was canned at Norfolk in Virginia in 1878 and also clams at Pinepoint, Maine, in 1870.

Shrimps from the Gulf of Mexico, which are more like the British prawn in size, were canned in 1867 by the Dunbars. Since the nearest town of New Orleans was 120 miles by water, along the coast and up the Mississippi, from the fishing grounds, a floating cannery was at first employed. However, after 1875, the availability of artificial ice permitted the fish to be taken to the city for canning. In 1880, 234,000 cans were produced. There were technical difficulties due to the meats darkening on contact with the metal of the can owing to the formation of black iron sulphide; cotton and later parchment paper bags were used to prevent this. In 1931, the pack was 860,000 cases.

AMERICAN SARDINES

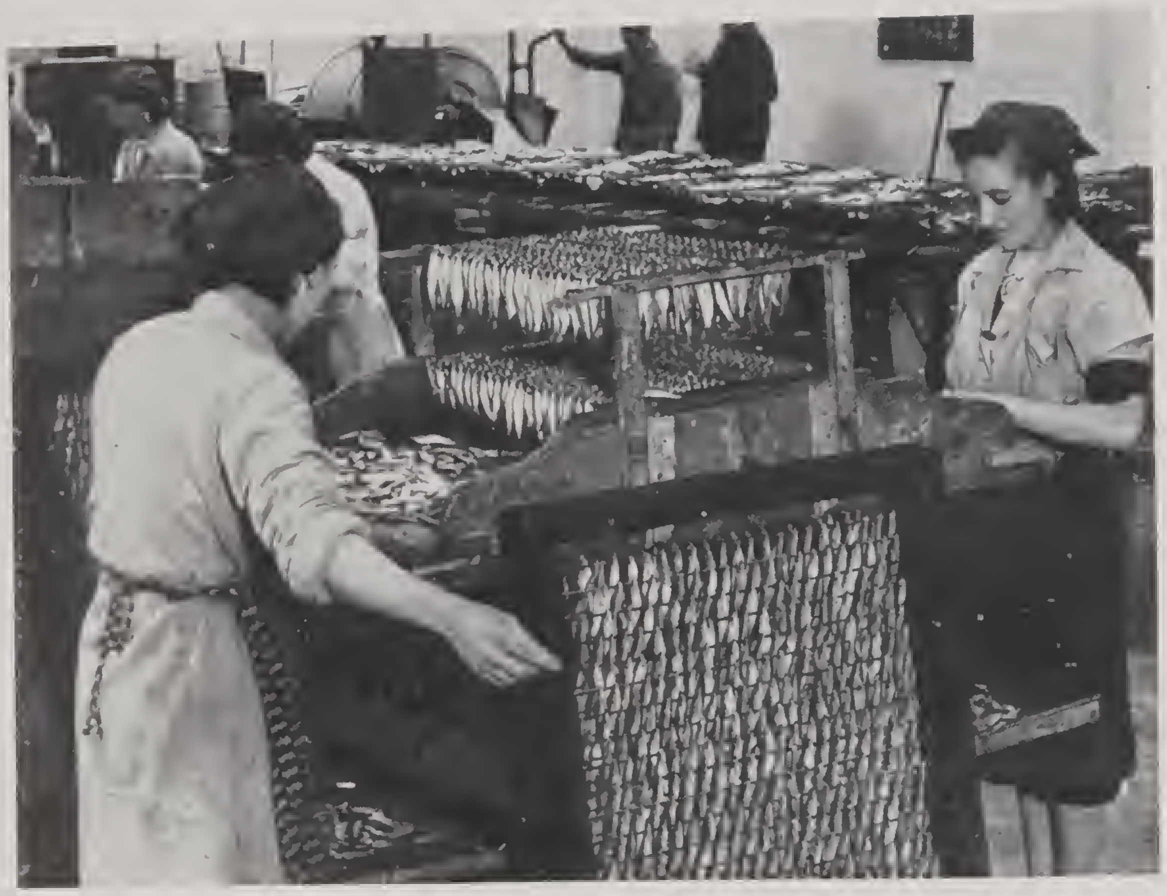
A number of attempts were made to find a pack resembling the European sardine. Immature menhaden, a species now used almost entirely for fish meal and oil, were canned at New Jersey in 1871 and sold as 'shadines'. They were soon superseded by a superior pack produced from young Maine herring. These had been canned experimentally about 1840, but it was in 1876 that Julius Wolff and Hermann Ressing of New York City set up the first successful canning factory at Eastport, Maine.

By 1906, there were canneries all along the coast of Maine and Maine 'sardines' became an established commodity, although there were legal arguments about the name. Large quantities were allowed to be imported into Britain under this name during the 1939–45 war.

The fish are cooked and dried by different processes in various factories along the coasts of New Brunswick and Maine. In some cases the fish are smoked at the same time as they are dried. Heads and tails are removed by scissors and the fish hand-packed into cans. It is not regarded as a 'quality' pack. Larger herrings are also filleted, smoked and canned as 'kipper snacks'.

Canning of Californian 'pilchards' or 'sardines' was started at San Francisco in 1889. It was given up and the equipment was transferred to San Pedro in 1896. In 1900, F. E. Booth, who had been canning salmon at Monterey and Pittsburg since 1898, packed a few pilchards in olive oil in ¼ lb. oblong cans made by hand. Since 'pilchards' were rather larger than the normal run of sardine, 1 lb. oval cans were used later. Production was not very great until the demands of war led to an expansion of the industry in 1917. In 1914, there were only two canneries in California, but by 1919, thirty were flourishing and the pack had increased in the same period from 8,500 to 2 million cases. The demand fell away for a time after the war, but by 1934 stood at 3,100,000 cases of forty-eight 1 lb. cans. Fish meal and oil, however, used to account for by far the greater proportion of this species. In fact, the fishery of this species, which although pelagic seems to have been overfished, was limited before 1939 by the expedient of insisting on a certain ratio between the amount of fish canned for export and that which could be converted into fish meal and oil. However, partly because of the diminished catch in recent years, between 1940 and 1949 the proportion of the catch canned for human consumption has increased from one-third to two-thirds. South Africa is now canning her pilchards on a large scale and is also finding it advisable to limit the quantities converted into fish meal.

The normal procedure in California is to scale the fish and head and gut them by machine, fill into cans by hand, and then convey through an 'exhaust box' where they are cooked in open steam at atmospheric pressure for about twenty-two minutes. If the fish have a high oil content, surplus oil is removed from the cans by inverting them before seaming.



(a)

PLATE 17.—(a) Rodding of 'sardines' (sprats) prior to smoking. (b) Sardine rodding apparatus.

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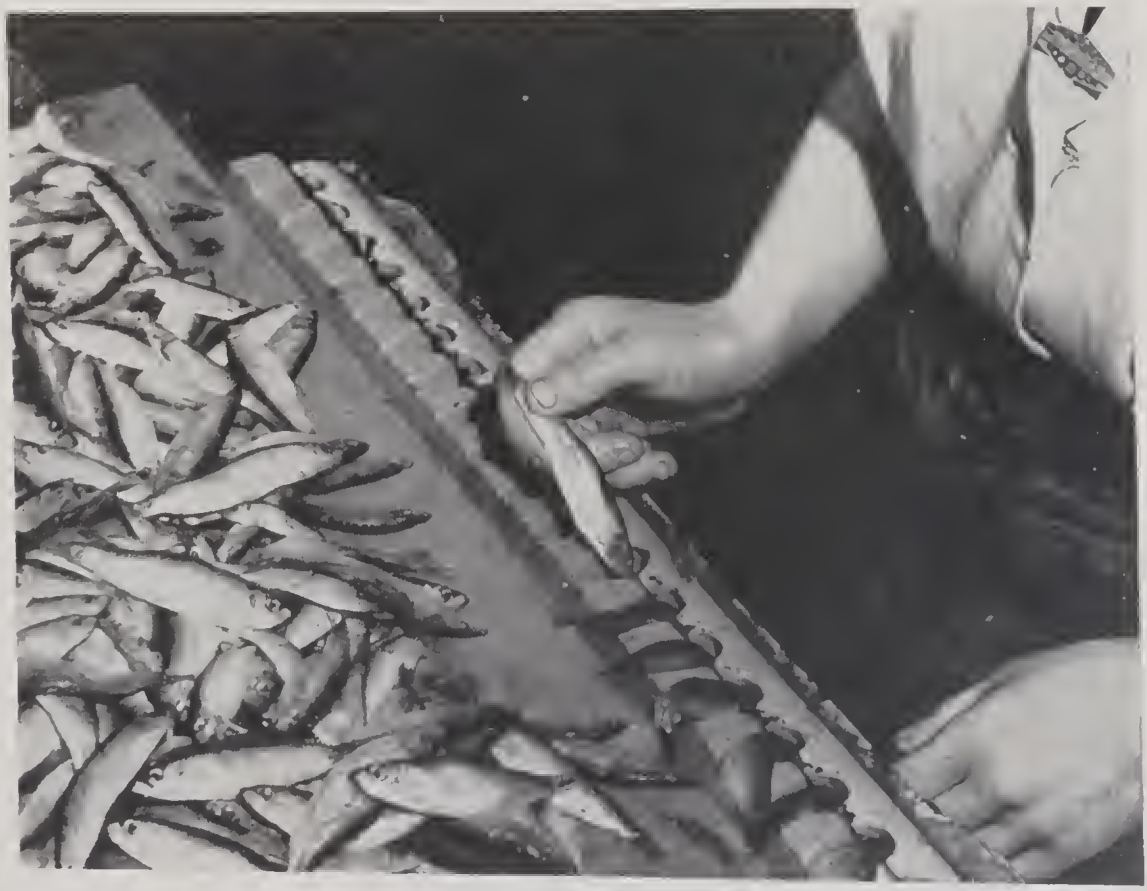
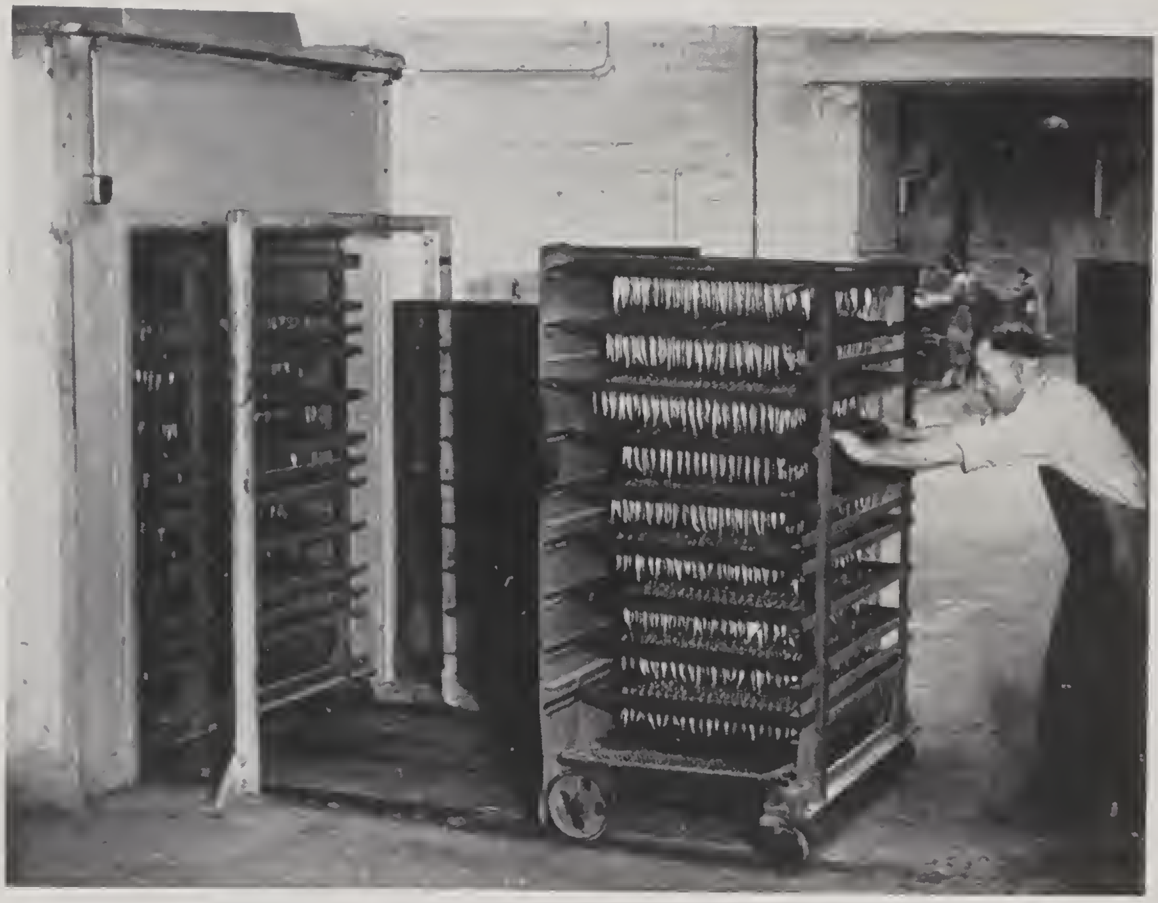
(b)



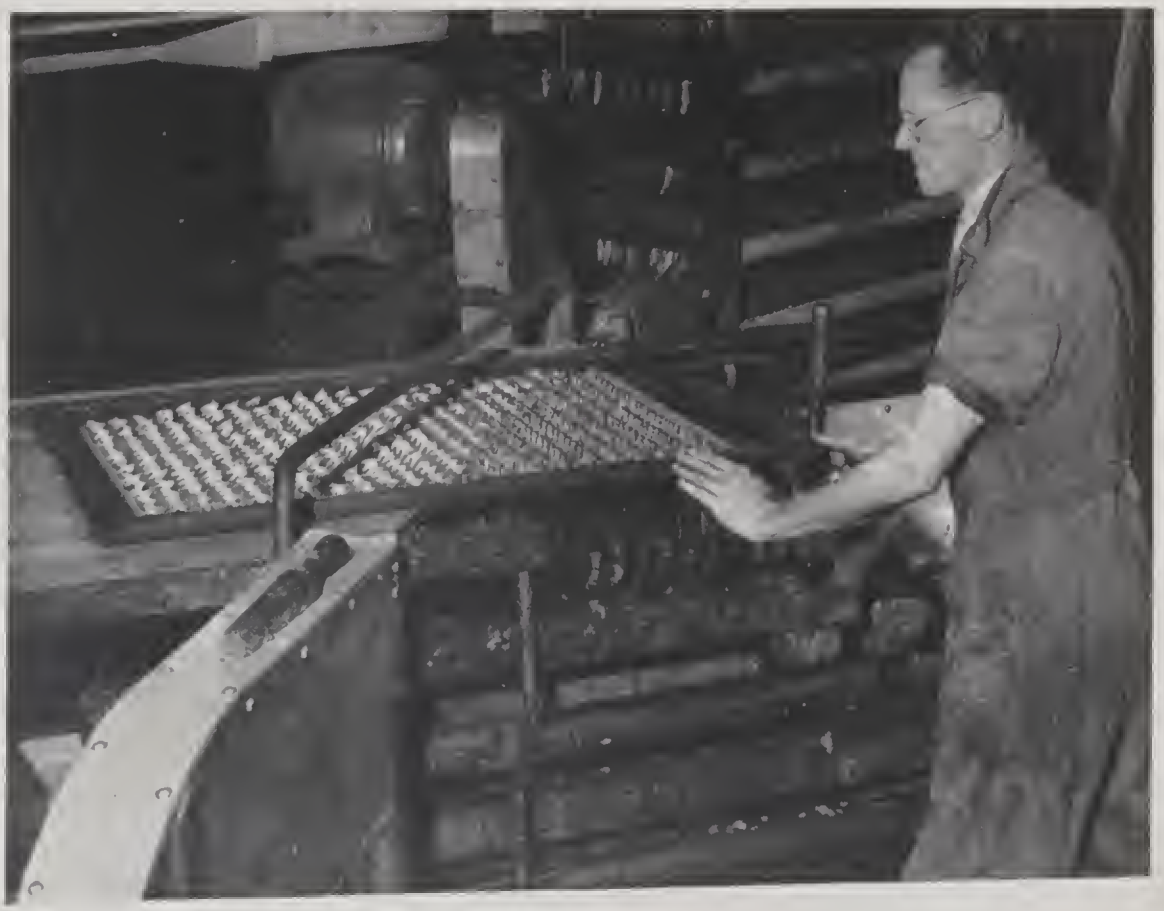


(a)

PLATE 18.—(a) Sardines entering mechanical smoking kiln. (b) Sardine beheading after smoking.

By courtesy of British Canners Ltd. Copyright Leonard Hill Limited.

(b)



CANNING OF TUNA

In 1903, when the sardines failed in California, 700 cases of albacore, a species of tunny, related to the mackerel and unpopularly classified as a 'scavenger', were canned by A. P. Halfhill and Spencer of Maine, at East San Pedro. After experimentation to discover the best cooking treatment for this rather tough fish, an extremely attractive pack in oil was developed, which amply justified its advertisement as 'the chicken of the sea'. By 1917, there were thirty-six canneries dealing with various species of tuna. Of 500,000 cases, i.e. about 10,000 tons, packed annually just before 1925, 41 per cent consisted of albacore, 25 per cent were yellow fin, and 26 per cent skipjack, which were not so highly prized. After 1925, the albacore left the Californian coast, but the bluefin which appeared instead was found to be excellent for canning. In addition, the yellow fin was increasingly exploited as far as Lower California. The light meat used for canning was separated after cooking from the darker portions which were converted into fish meal and oil.

The inshore fishery was superseded by the tuna clipper,which would cruise 5,000 miles in a year, freezing its catch (*see* p. 306). Finally, frozen fish were imported from Japan to supplement the raw material for this industry, amounting to 7 per cent of the home catch in 1928. Japan also started canning its own tuna with the assistance of United States technicians, and the various species of tuna are now amongst the most sought after commerical fishes of the world. It ranks second in importance to salmon as regards value. Ninety-thousand tons were produced in 1950 in the United States alone out of a total world tonnage of 140,000.

Of the several species now canned, the white-fleshed albacore is the most valuable, and forms an important part of the landings at Astoria in Oregon State although the biggest canning operations are at San Diego in southern California. The fish are gutted, washed, and scrubbed on a conveyor line and then cooked in wire mesh baskets in retorts at two to three lb. per sq. in. steam pressure for from one to seven hours, or more, depending on the size of the fish. The baskets are fed to a trimming line, where heads are removed, the skin rubbed off, the fish quartered, the backbone removed, and the dark meat along the lateral line removed. The fish quarters then go to the machine which cuts them into steaks of the correct thickness, pieces of which are then either selected by hand or machine to fill 7 oz. cans, or else packed as flakes.

The related mackerel, although not so highly esteemed, was canned in Eastport, Maine, in 1842, and in New Jersey in 1843, but it was not until 1927 that a sizeable industry was established in the Californian coast, when a Japanese firm at Wilmington packed 10,000 cases and sent them to the Philippines. By 1935 the output had reached 1¾ million.

THE NEED FOR SCIENCE

In the early days of canning, it was often a matter of chance whether the pack kept properly or not. For example, nearly one-third of the Humes' first year's canned salmon pack was lost owing to burst cans. Cans that did not explode during processing were liable to 'blow' later as a result of imperfect sterilization.

Such was the rough and ready organization and outlook of the United States industry, at least until close on the end of the century, that they were prepared to tolerate this uncertainty and wastage. A new outlook began to dawn in 1896, when two bacteriologists, Prescott and Underwood, (the latter a descendant of the pioneer canner, the former still alive) wrote the first classic paper on micro-organisms in canning. This was followed up by a similar investigation by Andrew (later Sir Andrew) McPhail on the discoloration of Canadian canned lobsters, about which there had been complaints from the United Kingdom. This work was reported in the Twenty-ninth Annual Report of the Department of Marine and Fisheries, Ottawa, in 1897.

Most canning factories, particularly in the U.S.A., now have scientific control of their processing based on acknowledged principles. The United States is still by far the biggest fish canning country in the world. Of a total fish catch, including Alaska, of about 2 million tons yearly, about 55 per cent is used for human food while the rest is converted into animal feeding meal and oil, etc. Assuming that the weight of fish canned is about 60 per cent of its landed weight, the total United States pack of canned fish amounts to about 29 per cent of the total catch or 42 per cent of the portion that is used for human consumption.[15]

THE FUTURE OF FISH CANNING

Most of the characteristic canned fish products, including salmon, pilchards, brisling, British herring, and South African crawfish, are canned mostly—if not entirely—for export. Many of the canned products are delicacies which rival or even improve on the fresh fish itself, e.g. in the case of tuna, which is otherwise a tough fish, and brisling which are improved almost beyond recognition by being allowed to mature for some months in the can. These products are mostly relatively expensive,and fall into the class of semi-luxuries.

Summarizing the present status of canned fish in the United States, Professor Harden F. Taylor points out that the great bulk of canned fish is in very few species, salmon, tuna, and sardines, which are known and accepted in world trade. Secondary lines include shrimp (inferior to, and in competition with fresh shrimp most of the time), mackerel, and oysters. In addition, there are so far as the U.S.A. is concerned, limited outlets for dog and cat food, cod fish flakes and cakes (the latter about two-thirds potatoes) and clams for chowder. 'To this may be added a long list of appetizers, *hors d'œuvres* and titbits, most of which are "dust catchers" on grocers' shelves. The business in these items is slow and difficult.'

However, viewing the world as a whole, it seems more likely that the immediate future lies in the expanded production for protein-deficient areas of cheap utility packs of the species of fatty fish, which are at present mostly converted into animal feeding meal and oil.[16]

Herring, pilchards and similar mass-produced pelagic species are still, generally speaking, canned only in a relatively small way, although the United States pack has risen from 60,000 tons in 1938 to 180,000 out of a world total of 390,000 in 1950. This increase largely accounts for the rise in the world pack of from 570,000 tons in 1938 to 810,000 tons in 1950, of which U.S.A. alone accounts for 425,000 tons. The further potential increase in output in this type of fish amounts to several million tons of fish a year[17] in the more highly industrialized regions of the world, if it could be diverted to human food from its present outlet in animal feeding meal and oil. In addition it is widely agreed that were the packs of this species made more attractive, they would then prove more popular in the industrialized countries such as the U.S.A. and Britain, where herring and later kippers have been canned commercially for about a century.[18] Generally speaking, there are ample quantities of pelagic fishes available, so that an increase in the popularity of these might in fact prove a welcome relief to some of the already 'overfished' white fish species.

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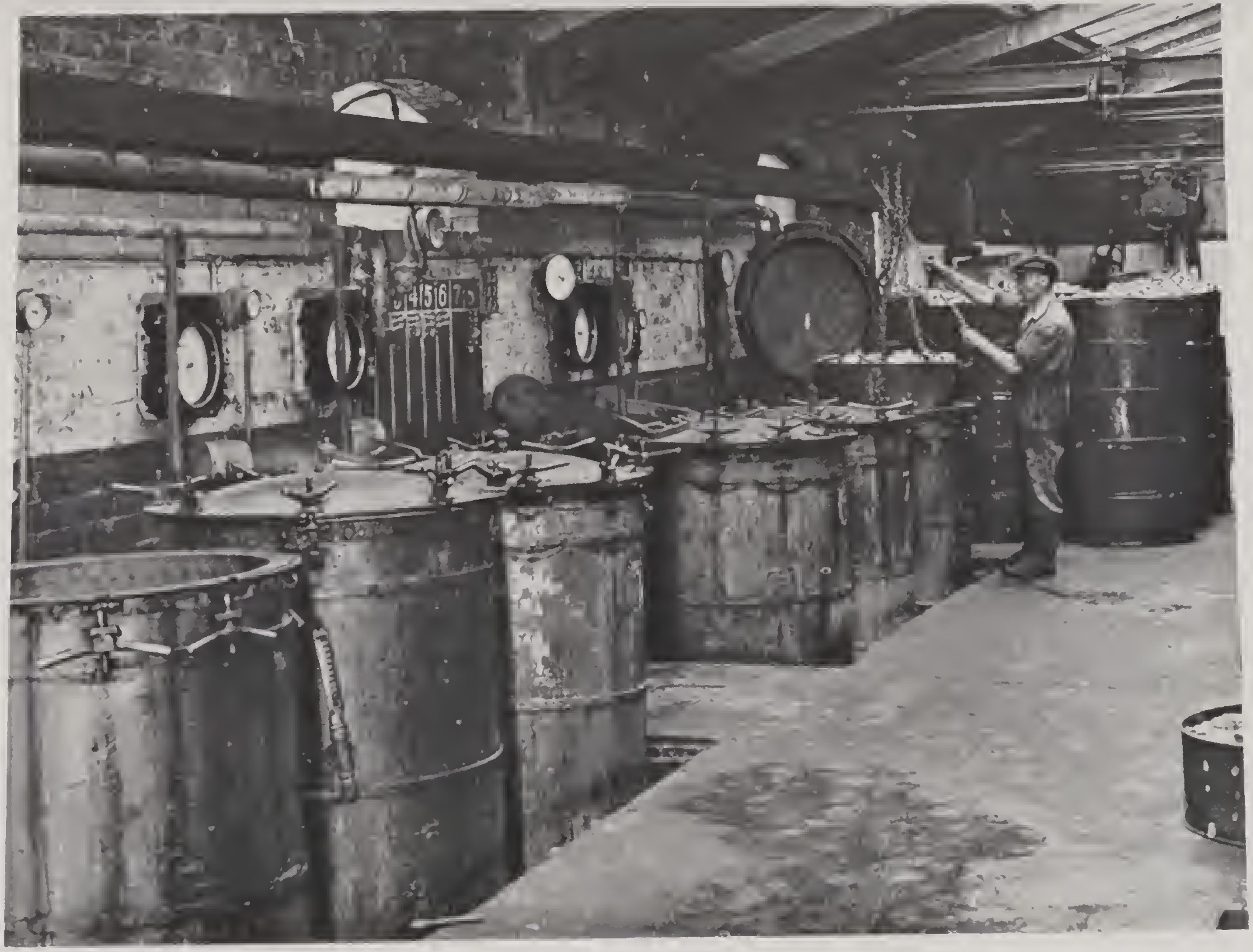

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PLATE 19.—Vertical steam pressure retorts for sterilizing cans of sardines.

Chapter 9

DISTRIBUTION OF FRESH FISH (I)

Live Fishing, Trawling, Ice and Railways

It is probably true to say that most people at all times, if given the opportunity, have preferred fresh fish and its flavour to that of salted, dried, and heavily smoked products (*see* p. 291). Consequently, the development of the fishing industry in the modern era has been a history of a succession of attempts to keep fish fresh between catching and consumption by various means, such as, 'well-boats', land-carriages, icing, 'fleeting', steam trawling, and freezing.

The considerations underlying various phases in the development of a distribution system for fresh white fish may be briefly summarized as follows.

In the first place, fish caught by hook and line were brought to port alive. When trawling developed, it caught more fish but killed most of them, because their gills were kept closed by the pressure of other fish at the 'cod end' of the net. They had, therefore, to be preserved by stowing with ice. As a result, however, trawlers could carry more fish than vessels landing live fish. Both methods demanded rapid land transport, provided ultimately by the railway network of the mid-nineteenth century. Finally, the changeover from sail to steam made transport home from the fishing ground more reliable, further increased trawlers' catching capacity, and permitted exploitation of more prolific distant areas, until a limit was set by the effect of delay between catching and landing on the quality of this fish.

WELL-VESSELS

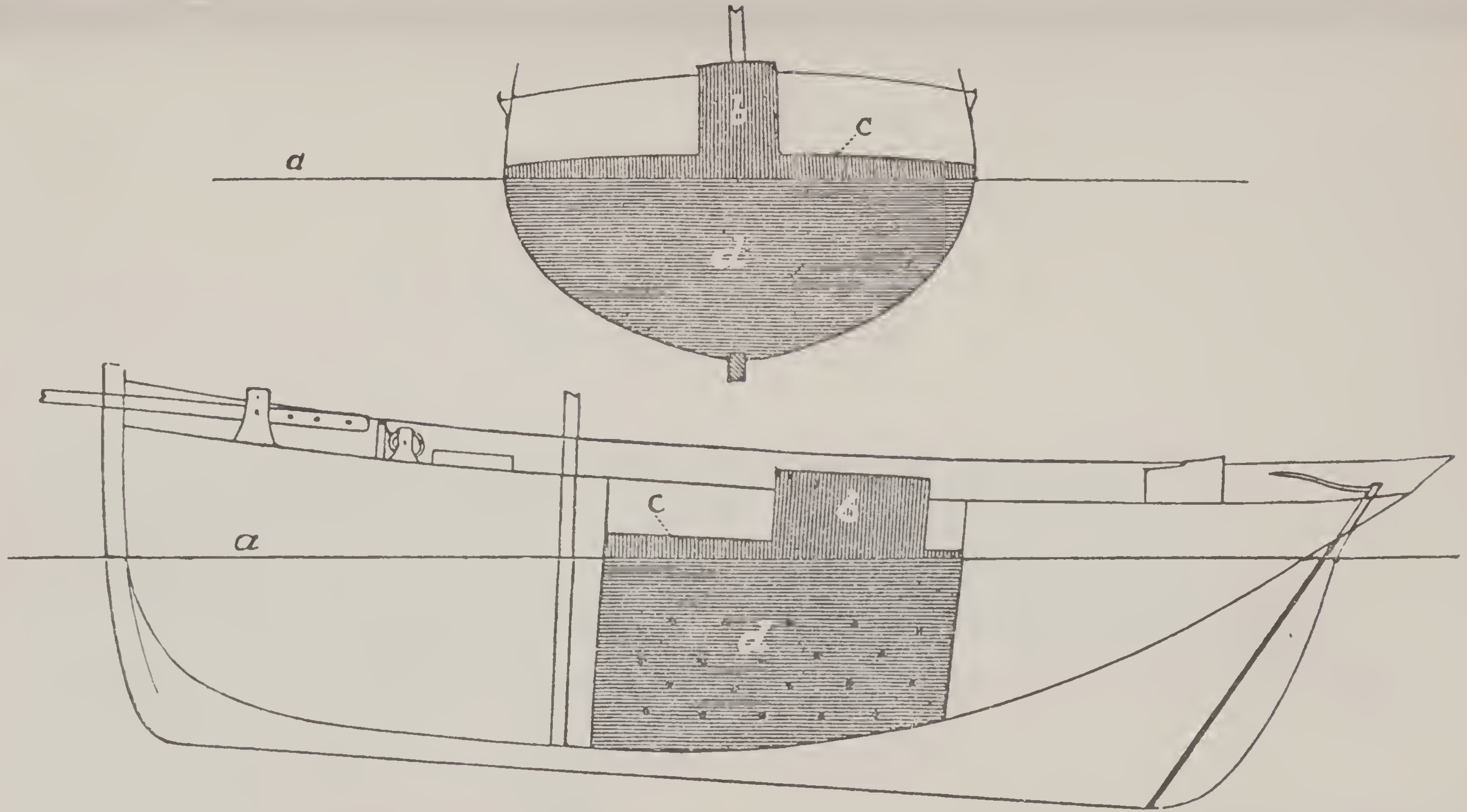
In the Middle Ages, fish were kept alive until landing in water at the bottom of the boat. In the seventeenth century there was a regular transport of trout from the north of England to London in 'wells' or tanks in ships' holds. At Tynemouth, expensive fish, such as turbot and lobsters, were kept alive in holes in the rocks awaiting transfer to the wells of ships. However, fishing vessels specially designed for bringing wet fish to market were first introduced in 1712 at Harwich, probably from Holland, where in the seventeenth century, if not earlier, fish was regularly taken alive from the Dogger Bank to the Catholic provinces of the Netherlands.[1] Even earlier, in 1668, 'Michael Mewe, Alderman of the town of Yarmouth . . . [was] praying licence to buy two well boats or pinkes in Holland for bringing live and Barell Codd of their own taking.' However, it was at Harwich that the trade was ultimately established and this port then became, for a period, a very important centre for the North Sea cod fishing, and the landing of live fish in this way continued for the next 200 years.

The vessels were specially constructed with two watertight bulkheads built entirely across the vessel from keel to deck, enclosing a large space in the centre of the vessel—the 'well'. The sides of the vessels were perforated with large auger holes bored below the waterline which permitted constant circulation of fresh sea water and the ships were built blunt nosed in order to facilitate the flow. There was a hatchway on deck and the 'well-deck' running in front and each side of it kept the level of water within limits when the smack was rolling or being kept down when under sail.[2, 3] Figs. 8 and 9 give two slightly different representations of their construction.

Defoe made note of special fish-sloops at Barking, called 'fish-pools', but quotes a conservative opinion that 'all the pretences of bringing fish alive to London market have not been able to do anything but what their fishing smacks are able on the same occasion to perform.'[4]

Well-smacks used to come up the Thames estuary as far as Gravesend and discharged their cargoes there into 'hatch boats'. These could easily be rowed up to Billingsgate in one tide, which at the flood runs for seven hours at an average speed of three knots. When markets were bad, the fishermen could wait at Gravesend with their fish alive in the boats. During the summer hatch-boats used to go down as far as North Foreland to collect fish, holding fifty to sixty bushels at a time. This method of transporting fish by water alive was more reliable than carting dead fish in vans in hot weather.[5]

By 1735, there were thirty such smacks at Harwich, a few of



By courtesy of Edward Stanford Ltd

FIG. 8.—Well-vessel. *From* Deep Sea Fishing and Fishing Boats *by E. W. H. Holdsworth.*

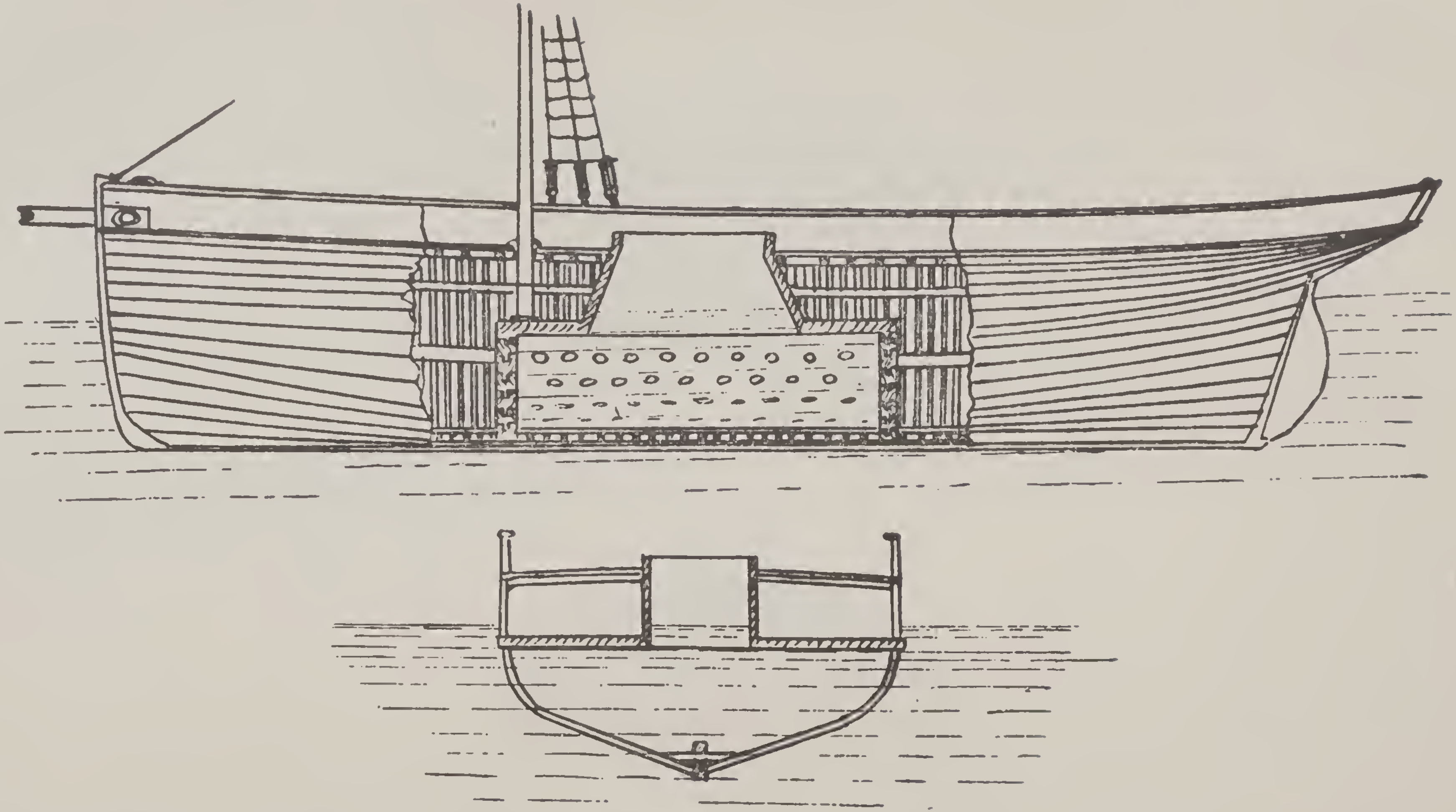


Fig. 9.—Well-vessel. *From* The Sea Fisheries of Great Britain and Ireland *by G. L. Alward* (Grimsby, 1932).

which fished off Scotland; four of them are reported to have ferried 'loyalist' troops across the Moray Firth to Inverness just before the final defeat of the Jacobites at the Battle of Culloden in 1746.

The Dutch first taught the English to use long-lines instead of hand-lines for cod and turbot. They were introduced to Harwich about 1770 by an Englishman who had been in Dutch service. Harwich 'well-vessels' then fished on the Dogger Bank with such success that by 1774, forty out of the sixty-two were fishing there. Towards the end of the century the Harwich fishermen were using mostly long-lines baited with lampreys and 'wilks', although some still used hand-lines baited with mussels and whelks. The Thames was once a great source of lampreys, yielding over a million a year. Greenwich, Gravesend, and Barking also sent fleets to the North Sea line cod fishing, which extended as far north as the Pentland Firth. The vessels averaged about fifty tons burden, but only caught about five tons of fish. They were victualled for five weeks, but often made the journey in less time. In 1799, 2,500 tons of fish went to London by smacks from the Dogger and North Sea.

However, all this industrious activity was unable to cope with the demand. The above quantity, if equally distributed over London's population of about a million amounted to only 5 lb. per head per year. The ninth edition in 1808 of a guide book, *The Picture of London*, published by Richard Phillips of Blackfriars, comments that 'The quantity of fish consumed in London is comparatively small, fish being excessively dear; and this is perhaps the most culpable defect in the supply of the capital, considering that the rivers of Britain, and the sea round her coast, teem with that delicate and useful food. There are not more, on the average, than 14,500 boats of cod, and other sea fish, brought annually to the London market; exclusive of mackerel which is sometimes plentiful and tolerably cheap.' The basic reasons for the high price of fish were the inefficiency of the methods of capture and preservation, soon to be revolutionized in mid-century.

After 1815, Barking smacks, the first of which was built in 1798, began to take the lead. In addition to going as far as Iceland for cod for salting (*see* p. 158), they fished for cod by long-lines on the Dogger Bank and off the coast of Lincolnshire and as far north as Northumberland on trips taking up to a month, bringing the fish back alive in wells. They also trawled for plaice off the Dutch coast, chiefly in the winter using light nets so that the fish were not damaged. The live plaice were put into large trunks which were sunk one under the other in the well and taken out periodically to remove the dead ones. They were landed at Yarmouth where they were packed in 'pads' (or baskets) and dispatched to Billingsgate in twelve hours, using forty-eight horses with twelve changes. They left at 5 p.m. and arrived at 5 a.m. Obviously, this was an expensive process and the fish commanded a high price from a class of consumer who could afford to pay it. Thus turbot of 3 to 14 lb. weight each sold in 1833 for about £3 to £3. 10*s.* per score, i.e. 3*s.* to 3*s.* 6*d.* each, whereas the average wages of manual workers and artisans at that time were only 1*s.* to 3*s.* per day. The highest prices were obtained at the beginning of the market. Thus, mackerel, dead of course, fetched 48*s.* to 50*s.* per long hundred before 5 a.m.; between 5 a.m. and 10 a.m., 32*s.* to 36*s.*; and in the afternoon 24*s.* to 28*s.* This factor, combined with the extreme perishability of the fish made it worth while to pay steam boats £20 for a tow up river to Billingsgate.

In 1833, there were 133 vessels of forty to sixty tons at Barking, whereas Harwich now had only ten. Owing to the closer proximity for the smacks of the Thames ports to the London market, the Harwich fishery had gradually declined and by 1852 there were only five ships left. Barking fishermen, also colonized some of the ports just outside the Thames estuary, such as Ramsgate, where there was a fine harbour, planned by Smeaton (died 1792) who had also rebuilt the Eddystone lighthouse in stone, and finished in 1828. There were only three or four smacks there at the beginning of the nineteenth century (cf. about a hundred in 1873). However, when the railway reached Harwich about this time, thus shortening the journey to London, the advantage of the Thames ports disappeared.

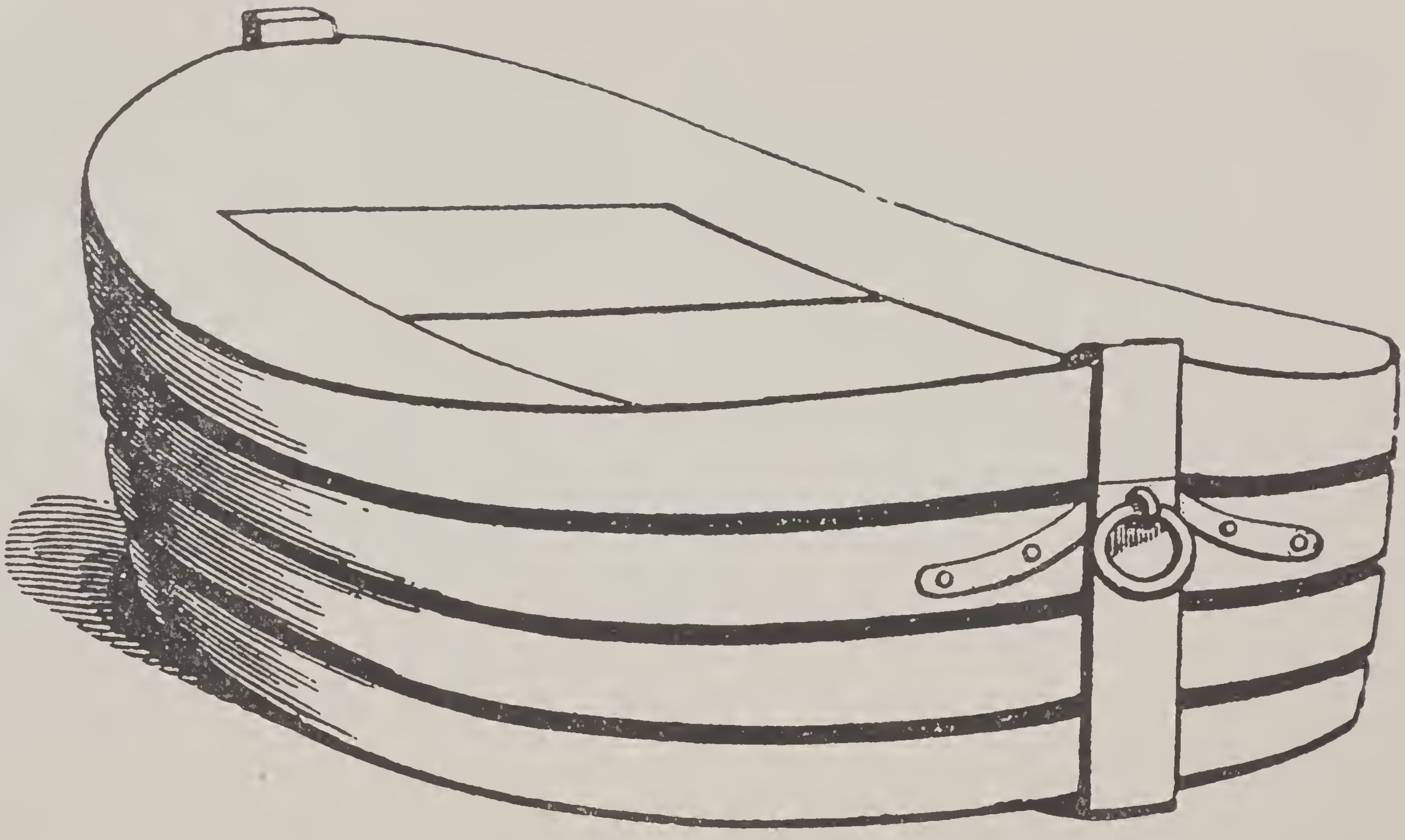
For a long time, therefore, Harwich continued to be used by the Thames smacks for storing live cod, after the Thames itself had become too polluted to keep cod chests in the river at Gravesend, etc. The grandfather of the present generation of the Hull trawler-owning firm of Hudson, was a Greenwich line fisherman. The Great Eastern Railway carried from Harwich

1,500 to 2,000 tons of fish, chiefly cod, yearly between 1860 and 1872. Fish were still being delivered there regularly in 1874. The fish were stored in chests moored in the tideway, which were rounded at the ends so as to offer less resistance to ebb and flow (*see* Fig. 10).

At Grimsby, where cod smacks were introduced about 1850,[6] a typical well measured about 20 ft. between bulkheads, being divided into three compartments of 6 to 7 ft. long and 4 ft. 6 in. high to the underside of the well deck. The space between the well deck and the underside of the main deck was used as a pound for storing salted or iced fish.

As bait for their long-lines, each vessel took on a trip about forty-five 'wash' (each of 43 pints) of whelks, which being tough were not easily washed off the hooks. A lead sinker weighing 3½ to 4½ lb. was attached to the line and gorges prevented the fish from swallowing the hook and suffering injuries likely to prove fatal. As soon as they were taken off the hooks, the cod were put into the well. Their air bladders, or 'sounds', had to be punctured first, since they got inflated as a result of pressure changes, and this would otherwise keep the fish floating at the surface in an unnatural position.

Cod was the principal species brought back by these cod smacks, as they were often called. If caught at a moderate depth it normally lived in the well for a week or two. Ling, on the other hand, which was generally caught in deep water, did not thrive as well, and nor did cod taken from a similar depth. Sometimes they lost most or all of their catch, the haddocks particularly being sickly. Live fish were never allowed to strike the deck or ground when thrown, but were always caught. Moreover, they were dropped into the well tail first so that they did not break their necks. Flat fish tended to lie along the bottom and sides of the well, choking the auger holes and preventing free circulation of water. That is why plaice were kept in open-sided trunks in the well. Halibut, which kept well, were tied with a cord by the tail, and skate by the nose, suspended on a wooden rod. There was inevitably some mortality even amongst healthy fish, particularly as a result of damage suffered during bad weather. Dead ('drowned') fish were taken out once a day and merely thrown overboard in the days before the salt duties were removed in 1825 (*see* p. 103), after which they



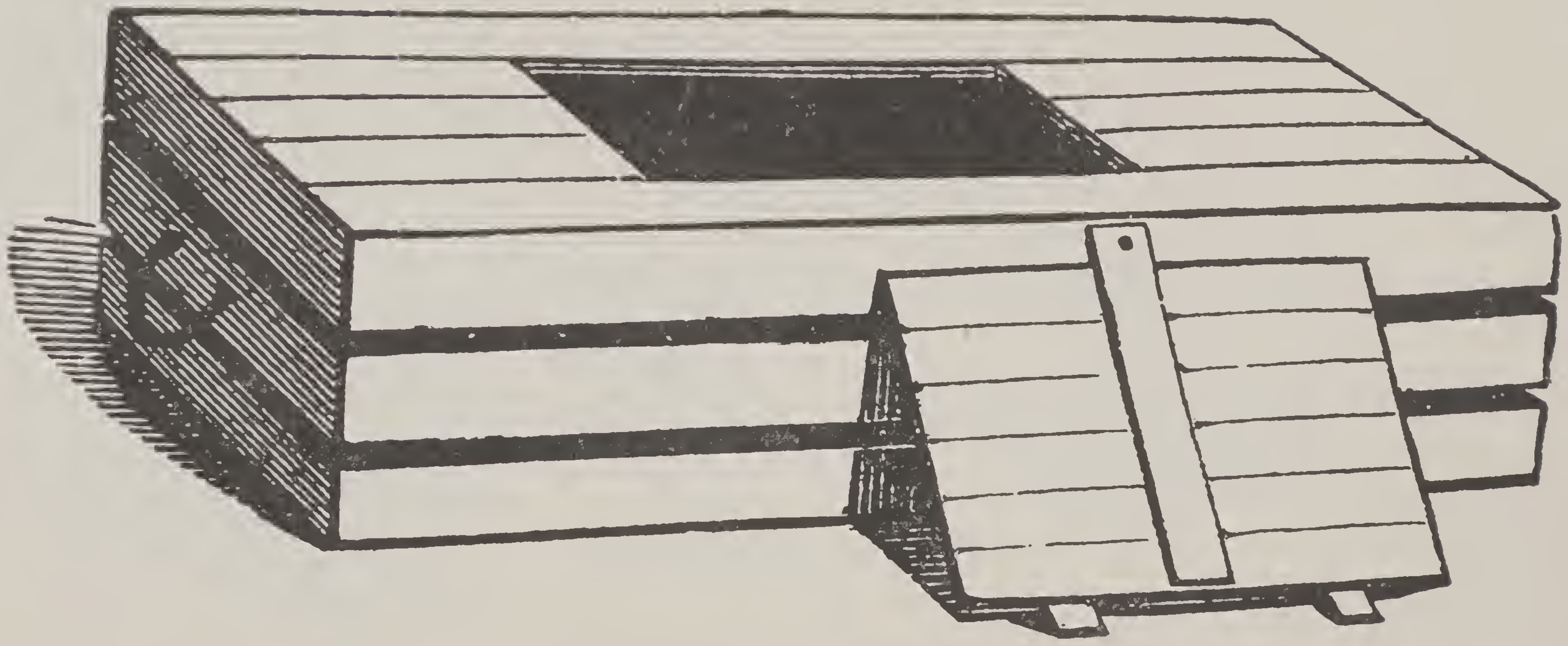
By courtesy of Edward Stanford Ltd.

FIG. 10.—Harwich live-fish box. *From* Deep Sea Fishing and Fishing Boats *by E. W. H. Holdsworth.*

were salted, and later still packed in ice. Fish which when taken off the hook were not considered lively enough to be put into the well, were also preserved.

At Grimsby, the cod were taken out of the wells by means of a long-handled landing net (*laddenette, see* p. 92) and placed in the wooden chests in which they were stored until wanted for the market. The chests were moored in the dock and could therefore be made rectangular, so that they stowed better, held more fish, and were less expensive in construction (*see* Fig. 11). They were 7 ft. by 4 ft. by 2 ft. in dimensions, and were made like crates with slatted sides to allow free admission of water. There was an oblong opening in the top which was closed by a cover when the chest was in use and afloat, and there were two rope or chain handles at the ends to facilitate moving it about and hoisting it out of the water. Each chest held forty good-sized cod, or nearly one hundred smaller ones, and the fish could be kept alive in them without any material falling off in condition for about a fortnight. Occasionally, haddock, which were of much less value than cod, would also be brought in and stored in this way. The chests belonged to individual smack owners, or a small number of them combining together for the purpose of using them for their own fish, or for letting them out to others, a charge of 9*d*. being made for a chest each time it was used. The chests were examined once a day and the dead fish, which floated at the top, were removed. Since the fish were not usually kept for very long, these amounted only to a small proportion.

There were usually about 400 chests in Grimsby fish dock; sometimes—particularly during the season October to January—all in use and containing in all 10,000 to 20,000 live cod. Even until the beginning of the present century they were still to be seen at Grimsby.[7] Every day, a certain number were taken out and sent off by rail to London and other markets. It was considered that the fish were firmer and kept better for the table if killed as soon as taken out of the water rather than dying a slow death from suffocation. The chests were brought alongside a hulk moored near the market and hoisted nearly out of the water by tackles from a couple of davits hooked on to the handles. The fish were taken out one at a time by head and tail and then thrown on to the deck of the hulk where another man



By courtesy of Edward Stanford Ltd.

Fig. 11.—Grimsby live-fish box. *From* Deep Sea Fishing and Fishing Boats *by E. W. H. Holdsworth*

stunned them by hitting on the nose with a short bludgeon (hence the appelation 'cod-bangers' for Grimsby men). They were then packed in bulk in railway trucks alongside, each truck holding about twelve score of good-sized fish, or proportionately more of smaller ones. Later in the century special cases were used for the rail transport of cod at Grimsby, of dimensions of between 12 and 15 ft. in length, 6 to 8 ft. in breadth and 3 ft. in height. Crushed ice was added to the fish in these and they were clamped and bound with iron. At the railway terminus they were hoisted on to specially constructed lorries drawn by two or four horses. Some of these boxes were even on wheels and these were merely lifted off the open trucks and horses attached. They reached Billingsgate in time for the market early next morning, when they were still quite fit for 'crimping', i.e., slashing transversely to avoid toughening when the flesh contracts in *rigor mortis* (*see* Plate 20). They commanded the highest price and were bought chiefly for the 'West End', according to Holdsworth.[3] The freight rate was 35*s*. per ton, but the fish sold for as much as 20*s*. each. Live ling taken from the Great Fisher Bank fetched 5*s*. to 6*s*. each but these were sold direct from the smack's well, as they could not be kept alive successfully in the storage chests. The ability to store cod alive at the port was a great advantage with a perishable product like fish since it buffered out erratic supplies and demand.

A typical Dogger smack towards the end of the nineteenth century would return with some twenty to twenty-five score of live cod and perhaps two-thirds of that number of fish in ice. Smacks remained at sea for a few days only, rarely as long as a fortnight, depending on the number of fish caught and the demand at the time.

The distribution of well-smacks in 1860 was, Harwich, 5; Grimsby, 14; Greenwich, 37; Deptford, 4; Gravesend, 10; Aldeburgh, 18. Barking had a total of 180 smacks of which 40 were in cod and 6 in haddock lining and the remainder trawling. It was estimated that there were at that time about equal numbers of well-smacks and 'dry-bottomed' vessels, which were engaged in trawling the North Sea. The well-vessels cost about 20 per cent more and their running expenses were also higher.

A wide area was fished including the Shetlands, Butt of Lewis, Flannan Islands, and even as far as Iceland. It was probably one of these ships that Ployen noted whilst he was in Shetland in 1839.[8] A sloop manned by eight men from London—probably Barking—landed twice in Scalloway within a month a total of 14,000 cod caught off the Faroe Islands. They usually landed in a fourteen week period two loads of split, wet-salted fish in the north of Scotland (*see* p. 159). On the last trip a well load of live fish would be brought back, either cod from Iceland, or else fish purchased from longshore boats on the way home, chiefly live turbot. The skipper was always provided with a certain amount of cash for this purpose, kept in the 'turbot bag'. In the winter, these sloops, which carried 200 to 500 barrels of fish, fished in Shetland waters, sending the catch to London alive in fast sailing smacks. The weather then was in any case unsuitable for drying salt fish in Shetland. Cod were landed at Billingsgate in long baskets called 'flaskets'. Four large cod in such a flasket would fetch between £4 and £4. 4*s.*; smaller fish eight to twelve to the flasket would make 5*s.* to 6*s.* each.

The live fish trade could not have been established at Hull because it is too far up the estuary for fresh, undiluted sea water.

During the summer season when cod was not plentiful, a number of liners carried live lobsters from Norway for the London market. The lobsters were packed in perforated boxes, holding three to six scores each, which were sunk in the wells. An average cargo was about 8,000 specimens of 7 lb. to 10 lb., or 18,000 to 23,000 smaller ones. When the smacks were becalmed in hot weather, the losses were sometimes enormous.

The decline in live-fishing towards the end of the century was due to a combination of the development of trawling and icing, with rapid rail transport to the inland wholesale market, which resulted in fish, suitably handled, reaching the consumer as fresh as the live cod and much cheaper. The last live cod from Faroese waters reached Billingsgate about 1880; but live-fishing survived at Grimsby, although on a decreasing scale, until into the present century.

THE FIRST USE OF ICE

The use of ice to keep fish fresh during transport seems first to have been advocated in 1786 for the transport of fresh salmon from Scotland to London by George Dempster (1732–1818)

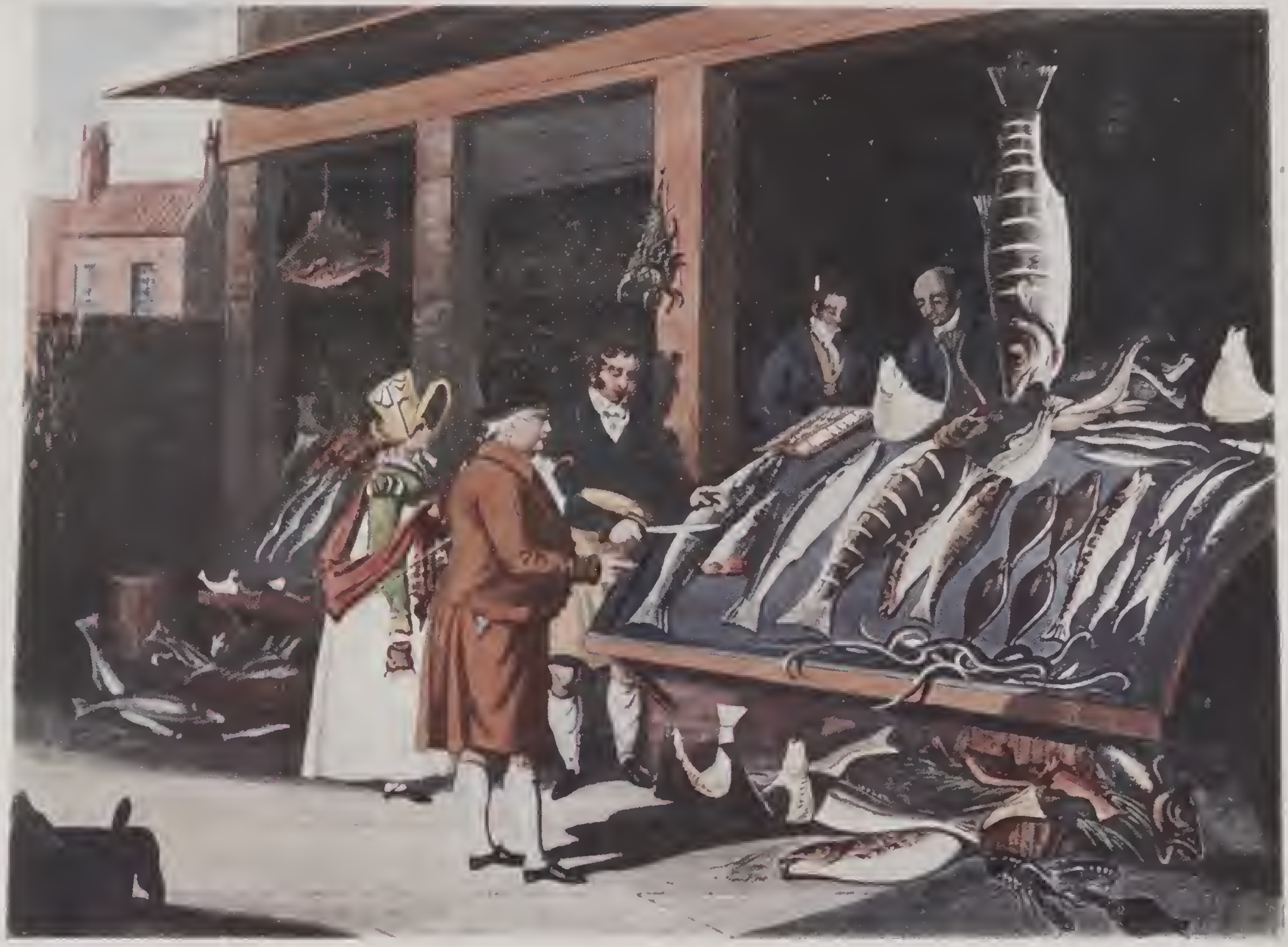


PLATE 20.—An eighteenth-century fishmonger's shop. *From* an engraving by *James Pollard* (*circa* 1795–1825).

(*see* p. 97). His own account in later years of how the suggestion arose was as follows:[9] 'Mr. Alexander Dalrymple, a faithful servant to the East India Company . . . told me the coasts of China abounded with snow houses: that the fishers of China carried snow in their boats, and by means thereof were able, in the heat of summer, to convey fresh sea fish into the very interior parts of China. I took pen and ink, and on the spot wrote an account of this conversation to Mr. Richardson, who, as well as others, has been in the practice ever since of conveying salmon in ice from the River Tay to London, and from Aberdeen, Montrose and Inverness.' Mr. Richardson showed his gratitude by a present of £200 to buy a piece of plate for Mrs. Dempster, and also acknowledged in a letter to the *Scots Magazine*, dated 3rd October, 1786, that he 'made the experiment rather in consequence of Mr. Dempster's earnest manner of writing, than in expectation of any good', and that, 'should any benefit result therefrom, either to the public or individual, to that patriotic gentleman, Mr. Dempster, it owes its beginning in this country and to none else.' Well might Robert Burns say in the Kilmarnock edition of his first poems, published in the same year:

A *Title*, DEMPSTER merits it;
A *Garter* gie to WILLIE PIT.

Although the poem, *To J. S*[mith], one of his bosom companions, about the pleasures of the simple life, is not without satire, it was not for nothing that the patriotic Scot was bracketed with the Great Commoner.

At the beginning of the century ice houses were built at all the chief centres for salmon. At Berwick, in one winter, 7,600 cart loads were stored. When neighbouring ponds and rivers failed to yield sufficient quantities, companies sent over to Norway for shiploads of 'lake ice'.

By 1814, according to the *Edinburgh Review* of April of that year, quoted by Bitting,[10] icing was 'the mode of preserving fish now adopted on all the eastern rivers and coasts of Scotland (and the West country), and we believe, in some parts of Ireland, by which means salmon is conveyed fresh to the capital of the empire . . . its adoption has been to many a source of great private emolument, and productive of much material benefit . . .

Till the introduction of the practice just mentioned, ice houses were possessed chiefly by the opulent and applied only to the purposes of luxury.* Every salmon fishing is now provided with an ice-house, for laying in a stock of ice during the winter. The salmons are packed in large oblong wooden boxes, with pounded ice interspersed betwixt them; and in this manner they are conveyed to London as fresh as when they were taken out of the water.' Although in what follows the *Review* writer is obviously very muddled in the difference between icing and freezing, the passage may perhaps be significant in indicating that all was not quite as rosy as had been painted. 'We have understood, however, that though they may thus reach London perfectly fresh, they do not always come to table in so good a state as salmons that have not previously undergone the freezing [*sic*] process, all from what has been already stated may fairly be presumed to arise from inattention in restoring the heat, or ignorance of the principle on which its restoration should be made.' Although it is quite possible that occasionally the ice applied to the fish may still have been sufficiently below its freezing point for the fish itself to begin to freeze by contact, it is very doubtful whether this can have been a frequent occurrence, any more than it is to-day.

In 1817, 7,206 100-lb. boxes of iced salmon from the Dee and Don were sent to London and the catch of the previous year was reported to have been much higher. A regular steam-boat service was taking the iced salmon to Edinburgh and London in 1838,[11] so that by 1849 a Scottish writer could say: 'steam navigation . . . gives to the inhabitants of London the finest salmon and in the primest condition . . . The fish are calculated to be preserved thus for eight to ten days, and in the height of the summer when the weather is at the warmest, six to eight.'[12]

During the closing years of the eighteenth century, herrings were taken in great quantities in the Forth by the Fife fishermen, and in 1794 these were packed into boxes, some with ice and others sprinkled with salt and sent by fast sailing smacks from Berwick to London.[13] It is reported that when the salt was washed off, the fish were perfectly fresh and 'of a quality equal to those usually sold in London.' It is not clear whether ice and salt were used in combination, as in the case of the 'klondyked' herring to-day, but it seems not unlikely.

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*Evelyn refers to them in his correspondence with the Hon. Robert Boyle, 150 years earlier.

THE BEGINNING OF TRAWLING

It was the railway, followed by the use of ice and steam trawling, that revolutionized the habits of fish consumption in this country, and converted fish from something in the nature of an expensive luxury into a food for the working classes. By the eighteen-fifties the railway had reached all the major ports and the enormous increase in the market for fresh fish thus made possible, combined with the continued rapid increase in the population, led to the need for new and better methods of catching fish, which in turn demanded new and better methods of preservation. As early as 1376, the Thames estuary and 'creeks and havens of the sea' were being fished by means of a net like an oyster dredge, dragged over the bottom because in that year the Commons petitioned Edward III to prohibit the use of this 'subtily contrived instrument' called 'the wondrychoun'.[2] A Commission met at Colchester to inspect the net, but no legislation ensued.

In the seventeenth century, trawling, probably introduced from the Zuider Zee, was quite common in bays and inlets on the south-east coast, the fish being transported to London by road. In March 1616–17, Mr. William Angell, the 'King's Fishmonger', issued a certificate to John Farsby, of Barking, 'to tralle for place and souls in such places as he can best find fish to be in and is usually fished bye any Cost men of Kent or elsewhere', and to bring 'weekly his fish to London yf wind and wether doe serve.'[1] These fish were probably landed at Hythe and forwarded by road. If kept during the whole week, they must often have been rather stale on arrival. The trawling activities of the fishermen of Rochester and Strood were in 1662 the subject of a complaint from the Mayor of Hythe to Lord Zouche. In 1631, there was a petition of fishermen on the Channel coast to the Privy Council about the Barking trawlers, which were using a 24-ft. beam trawl, and they were banned in a proclamation so that Charles I had to deprive himself of fish from this source. A sailing beam trawler is sketched on the back of one of the state papers in 1635, when

Charles again 'took into consideration the great destruction of fish by a net or engine called the Trawle.'[14]

BRIXHAM TRAWLING SMACKS AND THE TRANSPORT OF FRESH FISH

William of Orange, who had intended to land in 1688 at Hull but was prevented, fortunately for him perhaps, by a change of wind, arrived at Torbay with his Dutch fleet. This is held by some to account for the fact that Brixham fishermen along with the Barking men had a hand in developing beam trawling in the English Channel. In fact, James Anthony Froude, the historian, would have us believe that Brixham trawlers played a part in the defeat of the Spanish Armada, but this is surely an anachronism.

Although Brixham had been a fishing village since the fourteenth century, any precocity in trawling appears unlikely, since when Defoe visited Dartmouth about 1724, he would almost certainly have made some mention of the fishing industry had one existed then at Brixham.[4] The statistics of the times, too, such as they are, do not indicate that fishing was a principal occupation there. Although there is argument about the relative parts played by the men of Barking and Brixham in the development of British fisheries, it seems that the majority of the liners and trawlers fishing in the middle of the nineteenth century hailed from the Thames or Yarmouth, which the Barking men had colonized. Nevertheless, at Brixham in 1785, there were already seventy-six decked trawlers of 20 to 25 tons and twenty-five large boats chiefly engaged in lining. In that year 500 'machine loads' of various fish were sent to London. Roads by this time had been much improved, and a similar quantity of fish was being sent to Bath, Bristol and Exeter; in addition a 'vast quantity' was carried on horse, carts, etc. into every market town and village of Devonshire. The cost of transport was almost as great as that of the fish. In 1767, 1,751 cwt., chiefly turbot and soles, costing £2,626 at Brixham, was sent to Billingsgate at an extra cost of £2,127.

Hastings was nearer London, to which at the end of the century all its fish was conveyed chiefly by land carriage. Sometimes when wind and weather were favourable and there was a glut of mackerel and herrings, fish was sent by water, but this

By courtesy of Captain R. S. Hewett.

PLATE 21.—Samuel Hewett (1797–1871), whose enterprise in collecting ice from the Essex marshes so that fish could be iced at sea, revolutionized the whole industry.

was seldom and the venture was always risky. Fish sent by vans was exempt from post-horse duty but not from tolls. William Breach sent ten carriages of fish per day from Hastings at the height of the season. Between 1812 and 1816, 1,600 loads were sent; thus eight to 12 cwt. of fish was drawn by two horses at six miles per hour at a cost of 1*s*. per mile. The journey cost in all about £4. 5*s*. or about 1*s*. per stone, but the fish sold at between £20 and £30 per load. When supplies were scarce higher prices were realized. Thus in May 1807, the first van from Brighton reached £42 per long hundred, or about 7*s*. per fish, but the next load only made £13. 13*s*. Luggage vans drawn by four to six horses carried three times the load. These forms of road transport, although costly, were necessary in the days of sail when, with light winds, it took smacks two days to get from the Nore up to Billingsgate.[5]

After 1815, the price of fish at Billingsgate dropped and Brixham could no longer regularly supply the London market, owing to transport costs. The supply of fish reaching Billingsgate by water, chiefly from the North Sea, had increased in 1823 to about 12,000 tons, consisting chiefly of flat fish, sprats, mackerel, salmon, cod, and herring, in that approximate order. Billingsgate fish merchants were now using ice for holding fish over from one day to another, and for transport, according to an official report of 1833.

The Devon men moved eastwards along the Channel in the nineteenth century as much as anything in order to reduce transport costs to London. In 1812 some migrated to Dover to exploit recently discovered turbot banks, the fish being sent up to London, with some difficulty, in mail vans. Then they moved on to Ramsgate where, as already mentioned, there were Barking men and a good harbour. From about 1820 for over twenty years there was a regular winter migration to Ramsgate from Brixham from October to May. Smacks were increased in number and size. In addition to the 'hatch boats' which conveyed fish from Gravesend to Billingsgate, light vans were introduced in 1825 to take the best fish to London from near-by ports.

New fishing grounds were discovered off the south-east coast. These were also exploited by fishermen at other south coast ports. Folkestone supplied fish between April and September to country markets as far as Maidstone and Canterbury, whence it could be sent to London. At Rye Bay, some fish went to London by water, and occasionally by land, especially at the latter part of the season, but it was said to be 'very expensive' to do this.

Partly perhaps as a result of the increased exploitation, the fishing had fallen away considerably by about 1850, and this necessitated the spread up the east coast which marked a turning point, as described later.

Fish, chiefly hake caught by Brixham smacks off the south-west coast, was brought up the Channel by fast sailing cutters as far as Portsmouth and there transferred to light trucks drawn by horses, known as fish wagons, for the seventy mile journey to London. When through adverse wind and tide the daily fish wagon was missed, the fish had to be thrown overboard, since it would have been too stale the following day.

The Brixham fishermen would land wherever there was the possibility of a market. Some smacks fished in the summer in St. George's Channel for Liverpool, and in the Bristol Channel for Bristol and Bath. Others fished in the North Sea between November and June, but returned home in the summer because they could not then get their fish to London fresh enough.

Their fishing range was restricted by the need to land fish in fairly fresh condition: a week was the longest time fish could be kept on board. The greater part of the North Sea, including the Dogger Bank, was therefore inaccessible to trawlers. The coming of railways around 1840 enabled trawlers to go farther north and to open up new markets in the interior by ensuring speedy dispatch of fish to London and the inland cities.

In fact, the railway was at first used more for sending fish into the interior of the country than for bringing it to London.

THE 'SILVER PITS'

Brixham smacks began to explore the North Sea coast, landing their catches at Yarmouth for the first time in 1832, and Scarborough (an old established seaside resort, described in Smollett's *Humphry Clinker*, 1771) in 1833 or 1835, for consumption by summer visitors between about Whitsuntide and October. Hull, which, though a long way up the Humber, had a long tradition as a whaling port, was visited at about the same time, although already in 1821, one Ralph Crayke tried hard to induce two Plymouth trawler skippers to come there, mentioning that a large quantity of soles had been caught in 1817 by a boat from Flamborough, still a lively inshore fishing village. About the year 1843, when the Brixham smacks stayed later than usual at Hull, they were caught in a gale whilst trawling and accidentally discovered phenomenally rich flat-fish grounds, the Great Silver Pits, sixty miles from the mouth of the Humber.[2] Another account dates their discovery as 1837 and attributes it to William Sudds, who came from Ramsgate.[1] Hewetts' of Barking also claim the discovery. Quite possibly all accounts are correct.

The news spread to Brixham and in 1854 some crews decided to settle at Hull, perhaps on account of its port facilities associated with whale fishing. The type of trawler which had been used with success in the Channel and Irish Sea had to be improved before it could fish in the more turbulent waters of the North Sea, and fishing gear and methods had to be adapted to the new conditions. About three-quarters of the catch was thrown overboard in the early days. The only species normally kept were cod, soles, turbot, brill, and halibut; plaice, haddock, whiting, and ling being treated as 'offal'. It was stated by one trawler owner that in the early days they threw away a hundred tons for every hundredweight discarded later.

The practice grew up of pooling the catch of a number of ships on the grounds and sending it back to the market in one of the fastest smacks. This led to the trawlers fishing in fleets and sending the fish home every day by whichever vessel was returning. They then stayed about six weeks on the grounds and there was a constant succession of smacks joining or leaving the fleet. The fish were stowed in bulk and were hoisted out of the hold at the port by means of a steam crane. This practice was satisfactory in the winter, but in the summer, fish could not be landed fresh in this way. The Hull fleets then joined the Barking fleets and drew upon the services of their sailing carriers which used pond ice.

ICING AT SEA

Although ice was used early in the century for packing round fish to keep them cool during distribution, none was taken to sea whilst the fishing grounds were mostly only a few miles distant and the fish could therefore be landed every day.

It was the firm of Hewett of Barking, founded in 1764 and still in existence, which first used ice, before 1850, for preserving white fish at sea. They had previously pioneered the procedure of fishing in organized fleets under an admiral, pooling their catch daily and sending it direct to Billingsgate by one of their number. The use of ice to retard the spoilage of the fish gave these fleets greater range and flexibility, and enabled them to land fish in satisfactory condition, even in summer, after absences from port of a week or more, whereas without ice fish was stale after two days. These developments were due to the initiative and ability of Samuel Hewett (born 1797, *see* Plate 21).

Local farmers for miles around used to flood their fields in the winter, and collect the ice as a regular crop. Watchers were employed in various areas of the Thames marshes to see that as the ice was formed on ditches and canals it was not disturbed by skaters, etc. It was cut and carted to a warehouse at Barking; 2,000 to 3,000 men, women and children were engaged in gathering it in. Although the first supplies of thin ice were usually available in mid-November, heavy frosts did not normally set in until after Christmas, when it was hoped to lay in sufficient to last until the following November. As much as 10*s.* to 15*s.* was sometimes paid for a cart-load of about 30 cwt. of ice at the beginning of the season, when it was particularly valuable, decreasing as the season went on to 4*s.* at the end. The ice-house, situated in Abbey Road, then known as Fisher Street, was about eighteen feet underground and had walls eight feet thick. There was storage capacity for about 10,000 tons, so that probably getting on for twice this quantity was used annually, allowing for wastage. The thin sheets stuck together in the store under pressure. Often there were queues of carts outside, stretching right through the town, waiting to unload. Part of the ice store is still in existence.

Ice was at first scarce and expensive. Trawlers could not always get enough. They then had to shorten their voyages, or land elsewhere, or throw the fish overboard; much was condemned at Billingsgate. At first ice was used only in the summer, the fish being carried without any in the winter. If ice was scarce, only prime fish and the best of the 'offal' (viz. haddock and plaice) was taken, the rest being thrown overboard.

Haddocks particularly, at this time, before smoke-curing was developed in the 'fifties at the English ports, were almost worthless to the trawlers, and it was no uncommon occurrence for the bulk of this part of the catch to be thrown overboard, orders being given to the ships not to bring on shore more than were likely to be disposed of. Apprentices used to string haddocks up in the rigging to dry as perquisites, known as 'hazel haddocks'.

The enormous quantities of plaice now made available by trawling also resulted in that fish 'losing caste'. 'Live-plaicing' with welled smacks then went out of fashion, and in 1874 these were being 'used almost entirely for their original purpose of bringing in live cod.'[3]

The prices of trawled fish at Grimsby during the period 1860–64 were much lower than those of line-caught fish a little earlier. Prime fish, i.e. turbot, brill, soles and John Dory fetched 2½*d.* per lb., while 'offal fish', of which four times as much was landed, only reached about ¼*d.* per lb. and the demand did not keep pace with the supply. These prices were now well within the reach of the masses and fish was becoming a popular food. After mid-century, costermongers at Billingsgate purchased considerable quantities of fish, particularly small flat-fish for frying (*see* p. 239 *et seq*) and haddocks for smoking overnight after washing and salting in curing houses in the neighbourhood of Walworth and Kennington.

Sometimes ice was brought by sailing ship from Norway* or even from America, but local supplies were cheaper. Importation from America of Wenham Lake ice into Britain started in the first quarter of the nineteenth century.[15] Subsequently British custom for imported natural ice was transferred to Norway, Lake Oppegaard apparently being renamed Lake Wenham in order to retain the trade name. Towards the end of the winter the surface of the frozen lake was scored with deep grooves by means of a horse plough. Blocks of between 2 and 4 cwt. were then cut out by men using saws with long teeth. The cost was about 3*d*. per cwt. The blocks were slid into a ship's hold and packed with layers of sawdust. By the time there had been further wastage and handling, it was worth as much as 4*s*. to 5*s*. per cwt.

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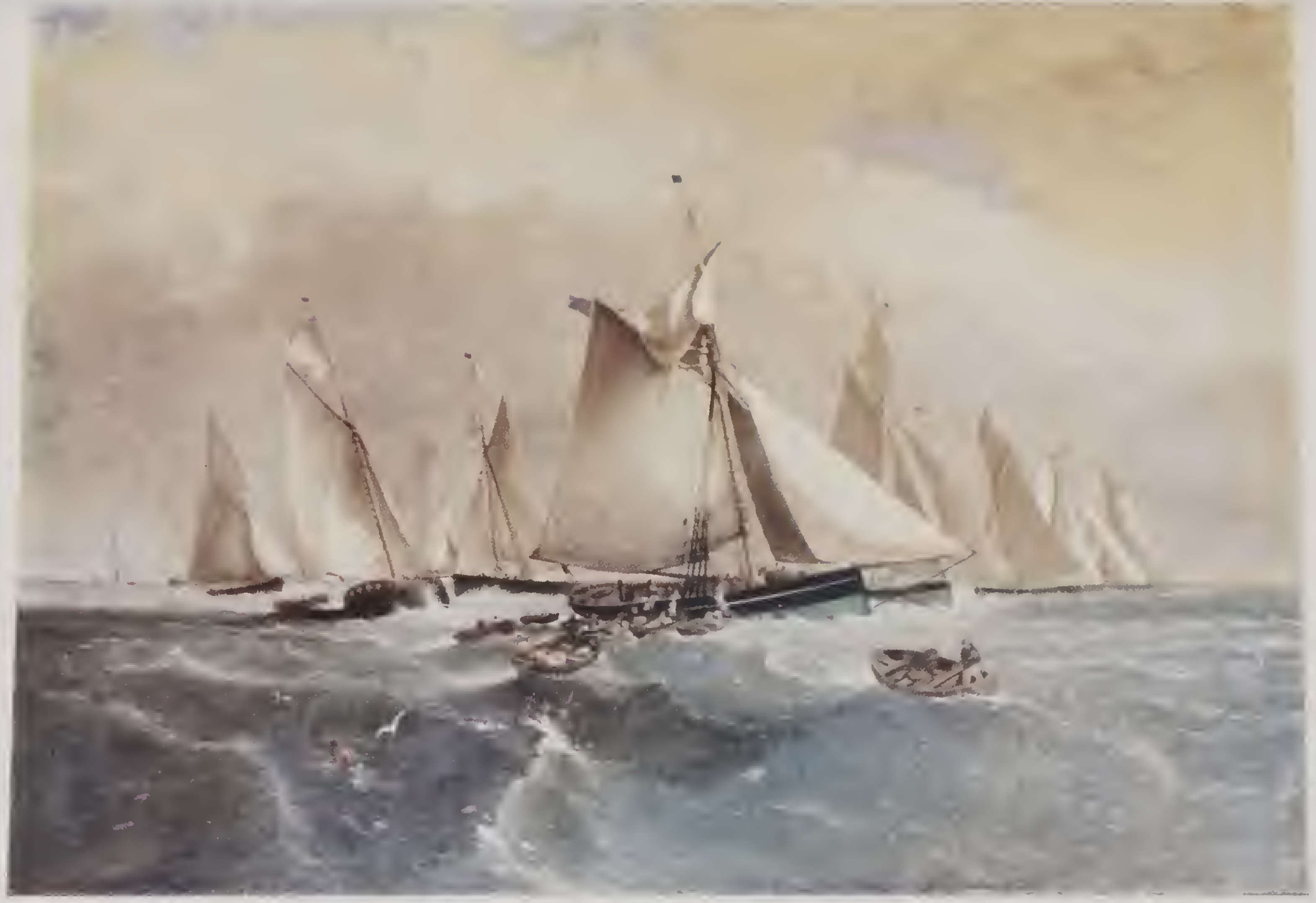
*Natural ice was, of course, much used by the Norwegians themselves. When in Stavanger in 1952, the author saw the old log-built ice store on a fresh-water lake, Mossvannet, being demolished.

The first artificial ice plant installed was also at Barking, but it was found to be too expensive to run. Later in the late 'nineties, cheaper ice was obtained from a larger plant of Linde at Shadwell. As a result of the adoption of ice, well-smacks gradually began to die out, because vessels with ice aboard could stay away from port for ten to fourteen days and still bring their fish right up to Billingsgate in passable condition. They could also carry a much bigger cargo, since dead fish could be packed a good deal closer together than live ones. Even more important historically, according to Captain R. S. Hewett, the present representative of the firm, was the fact that the use of ice enabled vessels to develop the trawl which although catching fish much faster than hook and line, landed them mostly dead on the deck, whereas live fish from lines needed no preservative.

As the vessels could now go so much farther away, they also took so much longer coming up to the market and the time of fishing was limited by the fact that they had a long way to sail to get back to Billingsgate. Samuel Hewett started to build special fast smacks (cutter-rigged) to act as carriers for the rest of the fleet. A number of smacks would thus all fish close together and every morning row up to the carrier with the fish they had caught in the previous twenty-four hours. By putting on all the canvas she could possibly carry, the carrier could frequently get the fish to London in twenty-four hours. Since the cutter carried ice, the fish arrived in nearly as perfect condition, as it would have been if taken to Billingsgate alive.

Fleeting vessels remained at sea for up to eight weeks, and then came back to Barking for about eight days to refit. However, they appear to have been victualled and watered only for six weeks and when they remained longer at sea, carriers took them fresh supplies. 'Fleeting', with its long continued absence from port, was not popular with the fishermen when it was introduced, and as early as 1844 led to a strike.



By courtesy of Captain R. S. Hewett.

Plate 22.—The *Short Blue* fishing fleet delivering to the carrier *Don*, 1860. *From* a painting by *George Earle*.

This system of fleeting and icing also benefited the men of Brixham ('Brickies') because it gave their smacks a regular outlet for their fish, and thus was indirectly responsible for the development of Hull as a fishing port. They sent vessels to join Hewett's 'Short Blue' fleet at sea and delivered fish to the Barking cutters in just the same way as the Barking smacks. A charge was made for carrying and selling the fish. The 'Brickies' did not tan their sails and their mast was farther aft. Their ships were faster, but they caught less than the Barking smacks.

This system made it possible to work the fish in different parts of the North Sea at different times of the year. A fleet of about 120 ships, made up to 200 in the summer when the Brixham men from Hull joined in too, used to fish the Dutch, German, and later, Danish coasts, in summer. In early spring, they commenced fishing off the Dutch coast, working along from Camperdown to the Texel, taking quantities of soles, turbot, haddock and plaice. Some time was spent off Vlieland Island. About 1st May they went down to Terschelling and by the middle of July finished up the season on that coast off the island of Ameland. After this they worked their way into the middle of the North Sea to 'pits' east of the Dogger Bank where in the autumn they took soles, brill, haddock and large plaice. When the frosts set in they retraced their course to southward of the Dogger Bank to the Silver Pits where, during the winter, they caught enormous quantities of soles.

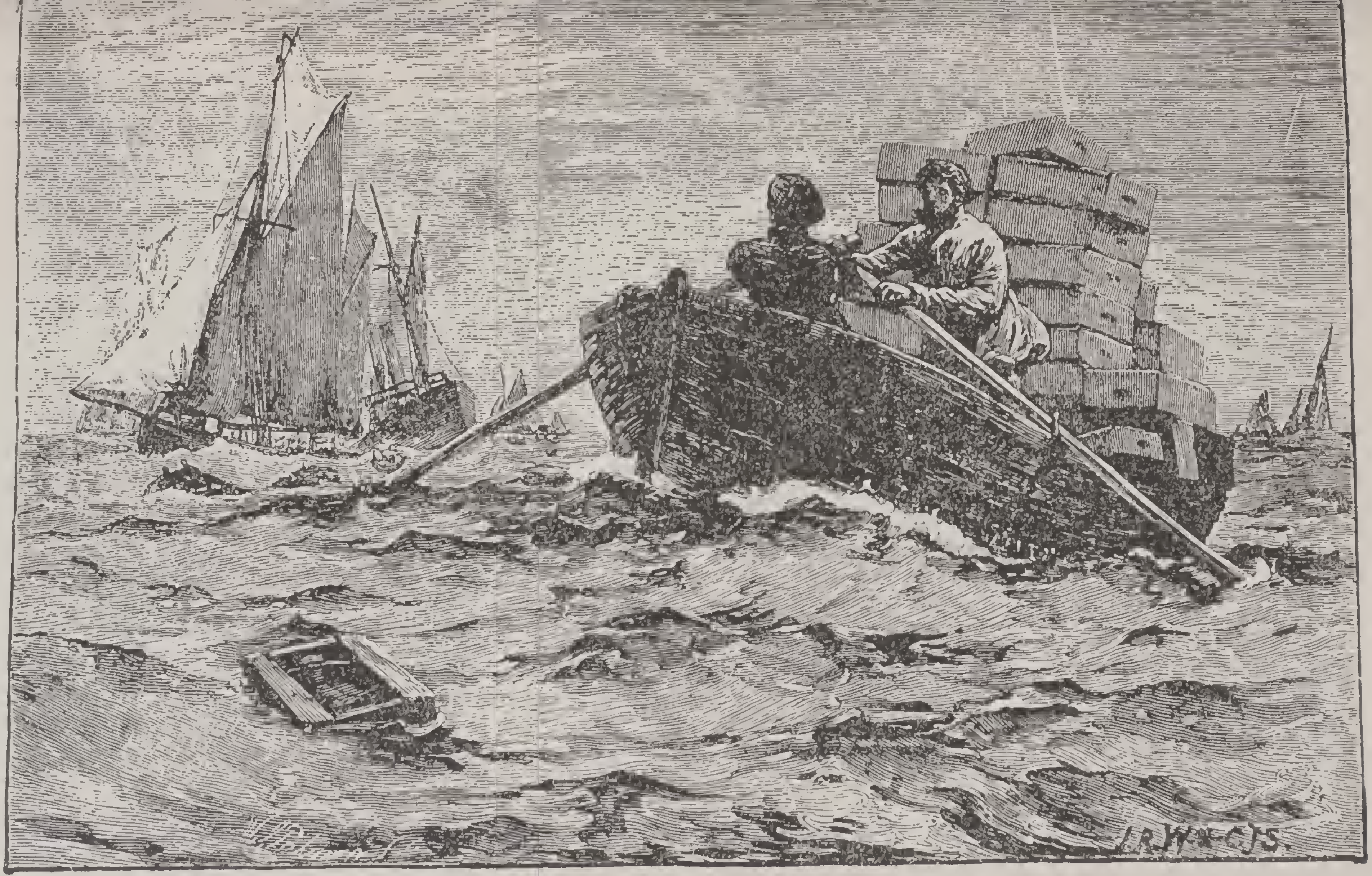
Fish was transferred from the smacks to the cutters daily in boxes or baskets, put in the hold and stowed in tiers with a layer of ice between each tier. The *Illustrated London News* of 10th September, 1864, in an article describing the Hewett business, depicted the operation as follows: 'A more exciting scene can hardly be imagined than when a carrier-cutter [which also fished] hoists her flag to take in a cargo for the market. The boats of the fishing fleet immediately throng around her with their boxes and hampers, rowing many a hard race to see which will reach her first. They hang on to her from bow to stern like a swarm of bees and package after package is literally rained upon her deck, until sometimes she has to make sail and force a passage from them, for the hardy fishermen have an idea that a carrier never can be overladen and accordingly pile their packages on board until it sometimes becomes absolutely dangerous.

As fast as the hands can work, the boxes and baskets are put into the hold . . . As fast as one carrier leaves, another ceases fishing and takes her place.' An artist, George Earle, even went to sea with the fleet in order to sketch the scene (*see* Plate 22).

'Fleeting' was a dangerous occupation, because in addition to the normal hazards of fishing in sailing ships, transfer of fish from trawler to carrier by means of a small boat, perhaps twelve trunks at a time, resulted in much loss of life and limb (*see* Figs. 12 and 13).[16] The boats, too, had to be hauled on to and off the trawlers. The imperative need to get fish into ice in the carrier to prevent it from going bad was in itself an incentive to taking risks. If the weather was too bad, the fish had to be thrown overboard. An additional hazard was the 'copers' from Holland which preyed on the fleets, selling drink and cheap duty-free tobacco. The Royal Naval Mission to Deep Sea Fishermen was founded in the 'eighties to combat these evils, and 'copers' were finally forbidden by International Convention in 1893.

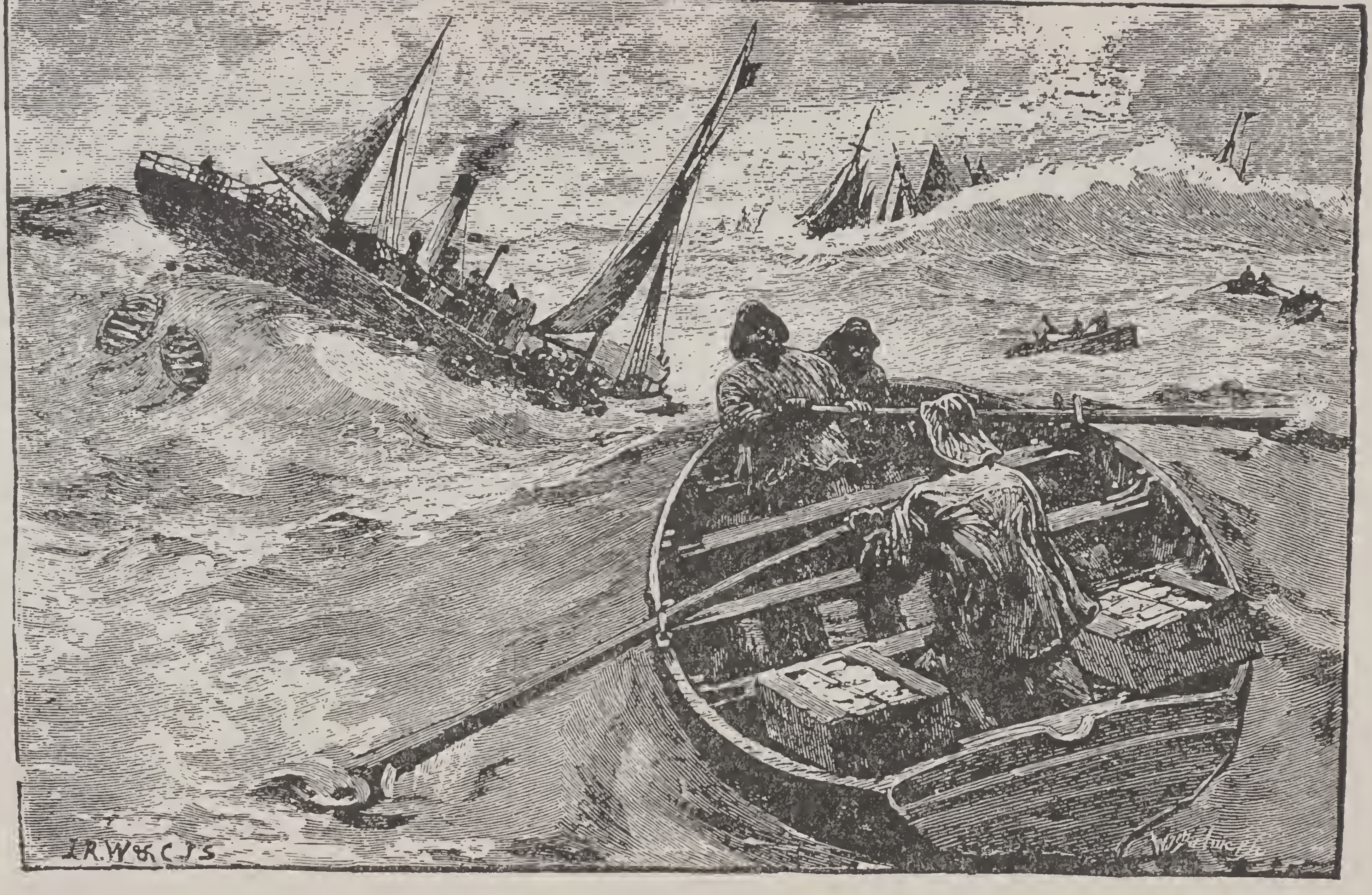
Each carrier held with 10 to 20 tons of ice in summer and 5 to 16 in winter, about 40 tons of fish and usually took about three or four days to reach Billingsgate. Ice was regarded at first chiefly as a means of cooling down the air in the fishroom and there was much prejudice against allowing it to touch the fish. Used in this way ice kept the fish moderately fresh for about a week. When there were calms or adverse winds the carriers arrived late, and sometimes they had to be towed a hundred miles to the market by steam tugs. Sometimes five days would elapse without a single carrier being able to get up to Billingsgate, with the result that, as stated in 1874, 'the cargoes of fish are greatly deteriorated in value, while the scarcity raises the price and imposes much hardship and inconvenience both on sellers and customers.' The ice for the carriers on the way from Billingsgate was taken from the Barking stores out of the Creek in specially built 'ice-lugs' and was loaded on to the carriers whilst they were lying alongside the coal hulks at Rainham.

Two other Barking firms also ran fleets, Leleu and Shuckfords' and Morgan. Coming to Barking to refit took a great deal of time, and in 1854 Hewetts' started transferring their fleet to Yarmouth, where there was no trawling before the arrival of the Brixham and Barking fishermen about 1840, and completed



By courtesy of Mr. J. H. Mather.

FIG. 12.—'Fleeting'—fine weather. *From* Nor'ard of the Dogger *by E. J. Mather.*



By courtesy of Mr. J. H. Mather.

Fig. 13.—'Fleeting'—foul weather. *From* Nor'ard of the Dogger *by E. J. Mather.*

the transfer about 1860. The Yarmouth and Norwich Railway was built in 1844 and the Eastern Counties and Eastern Union links in 1865 and 1867 respectively: Barking then began to decline as a fishing port. The nearer fishing grounds had been so depleted that longer journeys were necessary, and the railway now provided speedy transport to Billingsgate from other ports. Although ice was still taken on by the carriers at Rainham after landing fish at Billingsgate, ice-houses were also erected at Yarmouth.

In 1864, Hewetts' who 'had furnished Billingsgate for many years past with its principal supplies of fish' were employing 500 men and boys at sea with a weekly wages bill of £700. Captains received in addition a percentage on the catch. Hewett encouraged successful skippers to buy their own smacks and become skipper-owners, the firm still managing the vessels, keeping them in repair, providing with gear and stores, selling their cargoes, and charging freight on carriage to Billingsgate. It was some of these skippers who started to base their vessels on Grimsby in the eighteen-sixties, thus helping to found that port.

At Yarmouth Hewetts' continued and extended their 'fleeting', with steam-propelled vessels first employed as carriers in 1864. Although the first successful steam vessel was working on the Clyde in 1812, it was thought that the ice would be melted if near the boiler and that a very large ship would be necessary to avoid this. Also it was feared that a steamship would roll too much, to the detriment of the fish. However, their first two steam carriers, the *Hewett* and the *Lord Alfred Paget* (named after a M.P. and director of the firm when it first became a joint stock company in 1864—*see* Plate 23) were successful and ensured regular arrivals of fish at Billingsgate. They carried three times the cargo of the sailing carrier and delivered it in a third of the time 'as fresh as when taken'. In 1870, when fleeting was at its height, they had four steam carriers, still called 'cutters', after their original sailing rig, and in addition there were numerous other sailing carriers belonging to Barking and various other ports.

The *Supply* described in the eighteen-eighties, was an iron steamer, 100 ft. long and 24 ft. in the beam, built specially for the fish-carrying trade. It carried 45 tons of coal in its bunkers, 30 tons of ice in the ice-room and 3,000 empty trunks in its hold when steaming to the grounds. In 1881, the cutters made 286 trips, bringing to market over 375,000 trunks, or about 15,000 tons, which sold for £183,000, or nearly 10*s*. per trunk.

It was estimated that there were 12,000 fishermen in the North Sea between 54° and 56° N. in a total fleet of 1,500 ships. The 'Short Blue' fleet then stood at 220 'fine smacks' of 50 to 80 tons.

Fleets fishing near home used no ice even as late as 1880. The fish were caught one day, put on board the carrier the next, and sold in Billingsgate the day after, so that some fish were only twenty-four hours out of water; in fact plaice, which takes longer to die than round fish, were sometimes still alive. However, fleeting was not without its risks; on one occasion a fleet of 180 smacks, each with about thirty trunks of large plaice without ice aboard, had to throw their entire catch overboard when the carrier did not arrive on the day it was due.[5] Between 100 and 200 tons of fish reached Billingsgate in this way every day, all the year round. In 1882 immediately before the era of steam trawling 42,400 tons of fish were carried to Billingsgate by water, compared with 76,600 tons by land.

Storage in the customary wicker baskets (or 'pads') in which ice was merely sprinkled on top of the fish, had been replaced by Hewetts' well before 1880 by the use of wooden boxes (or 'trunks') in which, ultimately, the fish were 'iced through', so that their temperature was probably reduced to that of melting ice, namely 32° F.

Towards the end of the century steam cutters worked Icelandic waters in the summer, transferring fish from the trawlers in the lee of a certain big rock. However, the fish caught were mostly large cod and haddock which were too large for the standard trunks and were therefore gutted and packed in ice in bulk. They were not taken to Billingsgate but were disposed of at Shadwell market where prices realized were rather poor.

Shadwell, in the parish of Stepney, was intended by the Hewetts to be an up-to-date capacious market, with accommodation for hundreds of horse-drawn vehicles. It was set up in defiance of and in opposition to Billingsgate, which was already becoming congested with traffic in the eighteen-eighties. However, the Billingsgate merchants of the time flocked to Shadwell, where they bought fish cheap and then took it to Billingsgate

By courtesy of Captain R. S. Hewett and the Secretary, the Royal Thames Yacht Club.

PLATE 23.—General Lord Alfred N. Paget, C.B. (1816–88). From the painting by Sir Francis Grant, P.R.A.

where they sold it at a profit, so that the whole scheme ultimately collapsed.

In 1899 Hewetts' were still reported to be the largest fishing company in Great Britain, having absorbed Morgan's 'Gamecock' fleet and most of the other Barking fleets, too, into the 'Short Blue' fleet. But although, as they said 'Coal costs money, wind is free', the days of sail were over, and the fishing side of the company rapidly declined, a process accelerated by a disastrous boiler explosion at their Barking works in 1899, the loss from which was not fully covered by insurance. The last of the 'Short Blue' sailing trawlers went up for sale in Yarmouth in 1903. Since then Yarmouth has declined practically to nothing as a white fish port, although still the foremost herring port in the East Anglian autumn season.

THE DEVELOPMENT OF HULL

By that time the initiative had passed to Hull and Grimsby, still our two foremost ports. From two or three trawlers in 1837, the numbers at Hull had grown to forty in 1845, and 270 in 1863, and in 1872 there were 313 trawlers, averaging 55 tons. The Brixham fishermen at first landed fish at short intervals. Ice was introduced at Hull in 1859, when it was brought from Norway by Robert Hellyer (who left Brixham in 1854 and died in 1912, although the family is still prominent in Hull) and three others, and stored in sawdust in large warehouses. On one occasion, the whole stock was lost when a drain cock was left open at high tide; after that, upstairs premises were used.[2]*

At first there was some opposition to the adoption of icing on the part of some of the fishermen, who were not enamoured of the Barking system of remaining at sea for several weeks. They feared that the use of ice would mean that 'the owners were going to usurp and tyrannize over them and keep them at sea.'

In 1862, cutters commenced using ice and the owners fitted up twenty of the fastest trawlers to take iced fish from the fleet to Billingsgate in the summer months May to September, landing at Lowestoft if the wind was adverse. The fleeting trawlers themselves stayed at sea for ten to twelve weeks, and then all returned together.

*These premises in Anlaby Road later became the headquarters of the Salvation Army and it is still possible to hear the 'Icehouse Silver Band.'

Since the winds were often light in the summer, carriers had to be speedy if fish was to be landed in good condition. Between September and May, each vessel worked by itself, bringing in its own catch. By 1864, when ice was beginning to come into more general use, a few smacks had an ice box fitted up on board and were thus able to work independently of the fleets, landing wherever convenient, e.g. Sunderland or Hartlepool, to the great indignation of the local fishermen. They took two to four tons of Norwegian block ice, imported in several feet cubes, and ground it in a small hand machine for sprinkling between layers of fish stowed away in bulk as caught. It was at first used only in the hottest weather, when the fish room temperature could not be kept low enough by the sea. Port fish merchants, too, began to use ice sparingly for dispatch to inland markets and shops.

The advantages of ice were described in the standard *History of Kingston-upon-Hull* published in 1866.[17] 'Prior to the establishment of the new Ice Company in Hull, fishing smacks, when they had been a short time at sea, were either obliged to transfer their cargoes to a cutter, which conveyed them to London and other ports, or return to Hull themselves not half laden lest the fish should become bad. In spite of every precaution, large quantities were frequently destroyed as unfit for human consumption. But through the formation of the above mentioned company, ice can now be had at reasonable rates and as the fishing vessels are fitted up with ice boxes it affords the captains an opportunity of cruising about the fishing grounds until they have got a full cargo.' Hence the increased trade 'in fish by the time of writing.'

The increased use of ice permitted trawlers to extend the scope of their operations and this resulted in the discovery of new fishing grounds. In 1868, rich sole grounds were discovered off Denmark and the whole of the Dogger Bank was being fished. In 1875, they discovered the Great Fisher Bank, over towards the coast of Norway, about 250 miles from the mouth of the Humber. In 1881, the Shetland, Faroe and Iceland banks were being trawled over. Even by the end of the century, however, only 5 tons of ice was still a normal shipment for a trawler,[7] compared with 100 tons or more on a long-distance trawler of to-day.

As the trawling fleet grew, ice was more than ever relied upon, and soon became indispensable. By 1872, 16,000 to 18,000 tons of ice were being imported into Hull annually. Norfolk and Lincolnshire still furnished a considerable quantity of ice every winter. The trips lasted ten to fourteen days on the average. At the port, the fish was taken out loose and sold by weight; trunks were not used. The purchaser found his own containers, usually small barrels, holding ten to twelve stones of fish, known as 'kits', a term which has survived to this day as the unit in which the catch is measured. Fish was packed in these with a sprinkling of crushed ice between each layer and an extra quantity on top, covered with straw and tied down.

The use of ice by the wholesaler and retailer was now common. 'Almost every wholesaler has a large mill by which he crushes the block ice into small pieces about the size of a marble', said Holdsworth in 1874.[3] By that time icing at sea was almost universal, and 'nothing has tended so much to the development of deep sea trawling, and therefore to the large increase there has been in the supply of fish.' Fleeters, too, were beginning to take a certain quantity of ice to sea with them and they were further supplied by the carriers which went to collect the fish.

Fish was supplied to most of the large towns of England. The railway company sent out one of the smack owners all over England, Scotland and Ireland to open up new markets. He said: 'In many of the towns I went to, there was not a fishmonger's shop and never had been, and it was just a chance to have a few fish brought in by a hawker travelling with a donkey.'

The Hull vessels fished mostly in from 12–25 to 30–40 fathoms and rarely in more than 50 fathoms of water. Hauls were anything from 2 or 3 to 5 or 6 hours in length and it took from 30 minutes to 2 hours to get in the net, everything being done by human hand.

By 1869, the Albert Dock was completed at Hull and smokehouses first introduced for surplus haddocks about 1847 (*see* p. 283) had been erected in its vicinity by the merchants. However, railway freight facilities were still poor, so that 'fleeting' was continued and lasted longer in Hull than anywhere else. Four steam carriers were used to run fish from two fleets of trawlers alternately to Hull and London, where better prices were obtained. There was considerable congestion at Hull docks and often ships had to wait for three or four tides before they could enter. To avoid this, Hellyers' then ran both their fleets to London, although the new St. Andrew's Dock was built in 1883. In 1882 there were 420 sailing smacks and nine steam cutters as well as six ice vessels at Hull. In 1906 they gave Hull another chance, but again gave it up after ten months.

THE DEVELOPMENT OF GRIMSBY

Grimsby, although mentioned as a fishing port in earlier times, had long suffered an eclipse, and in the first half of the nineteenth century fish landed there had been used largely for fertilizer. The Manchester, Sheffield and Lincolnshire Railway arrived in 1848 and in 1853 and 1854 the company launched six ships, including two steam liners and the first trawlers to be seen there. In 1855, Howard brought six more lining smacks (well-vessels) from Manningtree, some Hull smacks and others arrived in 1858 and also some from Scarborough (e.g. the Alwards, who originally came from Brixham), while more well-vessels arrived from Barking about 1863. In that year there were 70 trawling smacks and 43 live cod smacks fishing out of Grimsby. In 1872, the numbers had risen to 248 and 82 respectively. The smacks were 35 to 38 ft. long and single-masted: 40 ft., then 60 ft., and later 90 ft. long vessels were built by Henry Smethurst, and Mudd, one of Howard's skippers, both still famous names in Grimsby. By the eighteen-eighties, ships of 120 ft. and 130 ft. in length were being built. Ships from other ports also landed at Grimsby and the landings rose from 1,500 tons in 1856 to 31,000 in 1872, which excludes carrier fish sent direct to Billingsgate. In 1858, the railway company offered fish merchants free railway tickets for the purpose of obtaining orders inland, thus further expanding the business of the port.

While live, line-caught fish were being landed at the market, no icing was necessary, except in transport. In 1858, ice from near-by ponds was first collected and stored for use in an ice-house with a thatched roof, erected by the dock company. Mr. James Sweeney was the first Grimsby owner to take ice to sea in that year, and soon afterwards it began to be customary for

By courtesy of Captain R. S. Hewett and the Secretary, the Royal Thames Yacht Club.

Plate 24.—Robert Hewett (1826–1904). From a painting by Maurice Codner, R.P.

smacks to take on board two or three tons of ice before a six- to ten-days' trip from an 'ice lug' which came alongside. The supply was precarious until regular imports from Norway were organized. These imports increased steadily, reaching 22,000 tons in 1872, 32,000 in 1880, and 62,000 in 1893. By 1900, 90,000 tons of ice per annum were being used.

Ice barques from Bergen landed two or three cargoes every week in a special berth just inside the Royal Dock. The Great Grimsby Ice Co. had five such carriers, named *Albatross*, *Flamingo*, *Pelican*, etc., which supplied ice to their own fleet of ships as well as to individual owners. The blocks were crushed in the ice factory and carted to the trawlers in sacks. A good deal of ice was also sent inland, the blocks being wrapped in straw and covered to reduce melting.

The use of natural ice was wasteful and supplies were uncertain. The next step was the large-scale application of refrigeration to manufacture artificial ice. Lowestoft, first 'colonized' by Ramsgate fishermen in the eighteen-sixties, soon after the railway connexion with London had been completed, had one of the first ice factories, the East Anglian Ice Co. Ltd., formed in 1875. Other ports soon followed suit, but it was not until the eighteen-nineties that the ice manufacture was introduced at a fishing port especially for use on fishing vessels at sea. Hull built a 50 tons per day plant in 1891, but still imported 14,000 tons of ice in 1902. At Grimsby on the threshold of the present century, an ice factory was built on the docks by the Consolidated Steam Trawling Co. to produce 300 tons per day. At first there was a prejudice against 'artificial' ice and well into the twentieth century occasional shiploads of 'natural' ice arrived from Norway.

'Fleeting' developed at Grimsby as at the other major ports. In 1867, gluts of plaice from the Dogger Bank led to catches being pooled and sent direct to Billingsgate by fast sailing trawlers which carried ice in the hold. Within a few years bulk fleeting was normal in the summer months, groups of thirty to forty smacks pooling their night's catch, which was bulk stowed in ice after putting below in fast cutters. By 1883 there was systematic fleeting throughout the whole year with steam carriers. Fleets of 100 to 150 smacks each fed four to five vessels of 100 to 150 tons and 50 to 60 h.p., which carried fish to the market in ice. The smacks carried no ice and, as at the other ports, remained on the grounds for eight to ten weeks before coming home for a week's interval.

THE DECLINE OF FLEETING

'Fleeting' was, however, never the institution in Grimsby that it was in Hull, partly because of the tradition of live fishing, possible only at the former. 'Single boating' was preferred, although water transport was much cheaper than the railway. Thus in 1883 the Great Eastern Railway charged 37*s*. 6*d*. per ton for taking prime fish from Grimsby to Billingsgate and 26*s*. to 28*s*. per ton for 'offal' fish, not including 3*d*. per package, or 5*s*. per ton for icing and 8*s*. 4*d*. for delivery, a total of about 50*s*. per ton or ¼*d*. per lb. 'Fleeting' was only regarded, according to Skipper Alward, as 'a temporary measure to meet, to some extent, a kind of compulsory method of conducting their operations on the fishing grounds at certain times of the year.'[2] However, with sailing ships, single boating was not economic in the summer owing to the distances of the best fishing grounds at that time from the port and the high temperatures which caused what was then regarded as excessive ice meltage. A carrier, on the other hand, could be filled in a few days by collecting fish from fleets of smacks. 'Single boating' was therefore of necessity more or less confined to the winter months until the advent of the steam-powered trawler in the eighteen-eighties (*see later*). After this 'fleeting' rapidly declined in Grimsby and the last organized fleet was discontinued in 1901. In Hull, on the other hand, fleeting continued much longer and survived the transition to steam (*see* p. 254).

SMALLER PORTS

In 1874, just before the era of steam trawling, it is noticeable, firstly that there were practically as many well-smacks operating as there were sailing trawlers, about 1,000 of each, it was estimated; and secondly, that although Hull, Grimsby, and Yarmouth predominated owing to their proximity to the North Sea grounds, the smaller ports were also expanding. Thus, at Brixham itself the number of trawlers increased from seventy in 1852 to eighty-five in 1863. These vessels mostly fished the local grounds. They sent a great deal of fish to Bristol to be distributed. Before the railway actually reached Brixham itself in 1868, fish landed from trawlers was sent away on light carts to the nearest railway station, at Paignton or Torquay, which in 1860 handled 606 and 248 tons respectively. Freight rate by passenger train to Billingsgate was £3 per ton. The fish were iced for rail transport, but not at sea when the fish was landed fresh every day. When fishing off Ireland, 2½ tons of Norwegian block ice were taken aboard to keep fish-room and fish cool, and it was the boy's job on the smack to break this up with a mallet. When fishing local grounds, two trips were put in every week and 10 cwt. of ice were then taken on each trip. When fishing in the Bristol Channel the ships were away for a week at a time, and took 25 cwt. of ice, landing fish at Milford Haven or Swansea. If working off the Cornish coast, they put in at Padstow, Newlyn or Plymouth. The establishment of railways led to the disappearance of the Gravesend hatchboats and four-horse posting vans. According to figures from the tolls at Billingsgate both these forms of transport fell away by more than 90 per cent between about 1855 and 1860. The number of two-horse van journeys doubled in the same period owing to the use of this form of transport between the railway termini and Billingsgate.

Plymouth had sixty-six smacks, mainly fishing locally in the vicinity of the Eddystone Lighthouse. There was little sale for skate in that part of the country and it was used for bait or manure. Ramsgate, too, had about one hundred trawlers in 1873. They depended on block ice brought from Norway and stored in ice-houses ashore ; first in Scandinavian brigs, later in a 150-ton schooner specially built for the job in 1869–70. About a ton of ice was taken on a week's trip in the southern part of the North Sea, or off the Dutch coast. When the London, Chatham and Dover Railway was built, surplus fish was taken to Billingsgate, the quantities increasing from 73 tons in 1863 to 585 tons in 1874 and 2,612 tons in 1880. Lowestoft which started relatively late and had only 32 fishing boats in 1854, had increased its numbers to 166 trawlers in 1863 and by 1879 had 260 fishing vessels, including trawlers, averaging 27 tons, as well as 258 smaller vessels of less than 15 tons. At its zenith in 1898 it had 247 trawlers, as well as 233 drifters.

Fleetwood, now the fourth port in Britain in respect of landings, first had fishing smacks in 1840. Colonists from other ports developed a fishing industry off the west coast. Southport had trawlers as early as the eighteen-thirties. Their fish was sent to Manchester by horse and cart, sometimes spoiling on the way. When the railway came to Fleetwood, trawlers then congregated at that port until about eighty smacks were registered there.

SCOTTISH WHITE FISHING

Scotland was slow in taking up deep sea fishing. Vessels were primitive, and it was not until 1856 that decked vessels were first introduced, at Eyemouth. Long before this, however, the Shetland fishermen had been going considerable distances to the Faroes and Iceland and even Greenland (*see* p. 165) in their small ships and schooners.

In Aberdeen, a 75-ft. fishing boat was built in 1835, but the local fishermen could not be induced to go far enough afield. In 1868, only one decked steamer of 26 ft. and one decked lugger of 30 tons were employed in the deep sea white fishing, although there were 124 open boats of 10 to 16 tons with crews of 5 employed in the herring fishing, and 112 open boats of 3½ to 5 tons with 3 men engaged in inshore white fishing by lines. The hooks were baited with mussels, worms, limpets, and crabs for haddocks and earthworms for plaice. Trawling was actually first tried at Aberdeen about the middle of the century but this was before the arrival of the railway and so much fish was caught that it had to be sold 'dirt cheap' locally ('one pennyworth of fish would have dined an average family' we read), and the experiment was not persevered with. However, by 1875 the grounds from north-east Scotland to the coast of Denmark had been thoroughly explored by English trawlers from the south. At Granton, trawlers did not appear until 1882, on the eve of steam trawling.

The phenomenal increase in the landings of white fish in the third quarter of the century consequent upon the use of ice, completely altered its status from that of a food for the rich to that of a food for the poor. The home market seemed practically insatiable. 'No matter what quantity they bring', said the London salesmen, 'there are purchasers for it all.' Even the 'offal fish' such as haddock and plaice were in demand when they could be kept fresh by means of adequate supplies of ice. Holdsworth, writing in 1874, says 'that a much smaller number of the trawler haddocks is now smoked than formerly, and many of the last fish are sent packed in ice to the fresh market where they readily sell at good prices.'[3] Already, however, there were strictures on the quality of this mass-produced fish. He says 'they may not have quite so bright an appearance as those obtained by the hook (although) the number of live haddocks sent to the market is trifling . . . The prejudice existing in some quarters against trawled haddocks is no doubt principally due to their generally less inviting appearance, owing to their being gutted as soon as caught, and because, from the large numbers taken at once, less care is bestowed on their packing than is desirable to make them look well on being landed.' Nevertheless, 'practically all the great markets are supplied with haddocks by the trawlers of the North Sea.' Plaice, too, when ice became more plentiful, ceased to be a despised offal fish and mostly jettisoned, but established a position as a cheap food. According to Holdsworth, it was then 'in great demand among the poorer classes in London and the large manufacturing towns, and makes an important contribution towards the supply of cheap and wholesome food.' A good deal of it was taken by costermongers.

The south and south-west coast continued to supply most of the hake and also whitings at certain times of the year. Turbot came chiefly from the North Sea and the Channel supplied some also.

Soles (Dover soles) came chiefly from banks off the Norfolk coast, and of course, from the Channel. Grimsby shops were, in fact, being supplied with this species from London.

The spread of railways increased the number of areas which could be supplied with fresh fish. The 'electric telegraph', too, by facilitating quick communication between wholesalers and retailers, meant that regular orders declined and the trade became more geared to market supplies rather than to regular demand, with resultant expansion in over-all turnover. Most fish now began to be consigned from the port rather than passing through London.

FRIED FISH AND CHIP SHOPS

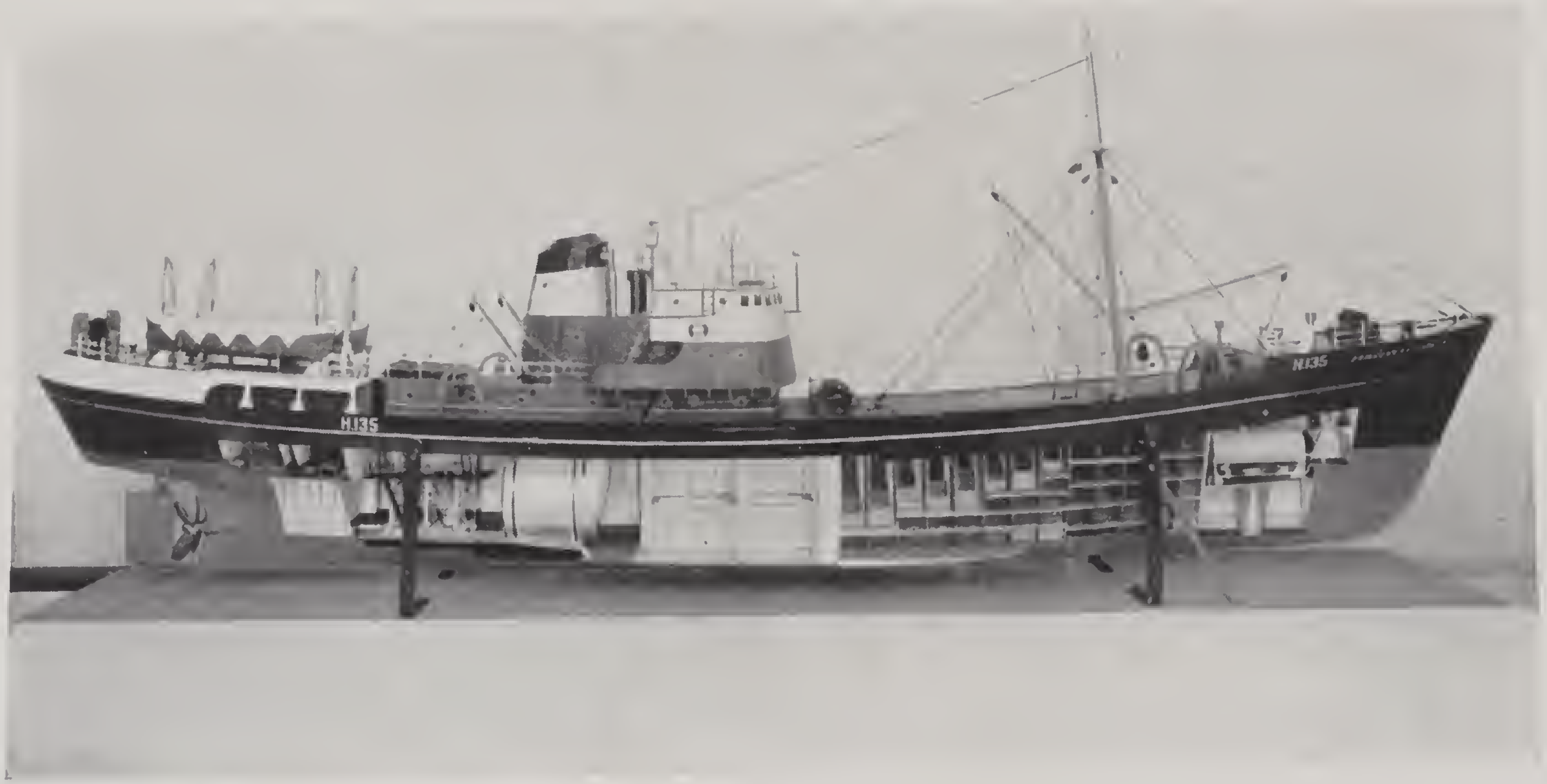
The rise of the British trawl fishery was accompanied by the growth of a new method of distribution, namely, the fried fish trade, which in a sense was also a method of preservation or at least of utilization of undersized fish, etc., otherwise not easily marketable. Dickens's *Oliver Twist*, written in 1850, has a brief reference to a 'fried-fish warehouse' in Field Lane, next door to a beer shop.

In Exhibition Year, 1851, there were already 'a few fried-fish shops', according to the London County Council Medical Officer of Health writing in 1906. Mayhew's *London Life and Labour* written in 1861, describes the preparation of fried fish as a trade then established for some years and estimates that there were some 300 persons in it

'The fried fish sold by street dealers is known as "plaice dabs" and "sole dabs", which are merely plaice and soles, "dab" being a common word for any flat fish . . . The supply is known in the trade as "friers", and consists of the over plus of the fishmonger's stores—of what he has not sold overnight and does not care to offer for sale on the following morning, and therefore sends to the costermongers, whose customers are chiefly among the poor . . . The fish to be fried is first washed and gutted; the fins, head and tail are then cut off, and the trunk is dipped in flour and water, so that in frying, oil being always used, the skin will not be scorched by the, perhaps, too violent action of the fire, but merely browned . . . The fish is cooked in ordinary frying pans . . . The fried fish sellers live in some out-of-the-way alley . . . in some of the labyrinths of the courts and alleys that run from Gray's Inn Lane to Leather Lane, and similar places between Fetter Lane and Chancery Lane. They are to be found, too, in the courts running from Cowcross Street, Smithfield and . . . Clerkenwell; also in the alleys about Bishopsgate Street and the Kingsland Road and some in the half-ruinous buildings near the Southwark and Borough Roads . . . "A gin-drinking neighbourhood suits best", one coster said, "for people haven't their smell so correct there."'

Fried fish was commonly sold with baked potatoes. About 1870 the trade was revolutionized by the practice of combining the sale of fried fish with that of chipped potatoes, introduced from France.

An account of 1876 makes it clear that by that time the trade was established in shops which were 'a source of considerable nuisance in some neighbourhoods, the offensive smell of the



By courtesy of Cook, Welton & Gemmell Ltd.

PLATE 25.—A modern Hull steam trawler, the *Princess Elizabeth*. Over-all length 205 ft.; length between perpendiculars 185 ft.; breadth 32 ft.; depth 16 ft.; oil-fired boiler 1,300–1,400 h.p.

oil boiling and fish frying spreading often through the whole length of the street where the shop is situated, and sometimes into the adjoining streets also . . . There is . . . scarcely a health officer in London who has not at some time been called upon by the authority under which he acts to advise as to an appropriate remedy for this nuisance.'

The pans consisted of open cauldrons, built into brickwork and fired by coal. The frier himself was often an ex-stoker and Mr. W. Loftas, at one time secretary of the Fish Friers' Federation, paints a horrific picture of such an early fish and chip shop:

'He used to manipulate the fires with a long-handled shovel, and to all appearances gave one the impression he was firing up a factory boiler. While the great panfull of chipped potatoes was being cooked, he would, in the intervals between "firing up" and "stirring up" the contents of the pan, stand behind the counter with his greasy hands in his pockets, chewing away at a great "quid" of tobacco . . . [some nauseating details are omitted] . . . These operations successfully accomplished with as much splash and splutter as possible, he would advance to the counter and in stentorious tones ring out: "Come on, in your thousands; we are the people who feed the hungry. Come on, pen'orths; stand back ha'porths." '

The chipped potato 'caught on', particularly in Lancashire, perhaps because with so many women there employed in the cotton mills, a cheap, ready-made, hot meal satisfied an urgent social need. Lancashire engineers, too, developed improved frying ranges, which carried away the steam and smoke so that less obnoxious smell was produced and, as a result, the fried fish shop gradually became more and more tolerable and, ultimately, quite respectable. By 1913, when the Lancashire Federation of Fish Caterers, founded in 1907, was reorganized as the National Federation of Fish Friers, it was estimated that there were over 25,000 fried fish shops in the country, which consumed at least a quarter of Britain's annual catch of some 800,000 tons of fish. The figures are not far different to-day.

SHELLFISH

Shellfish are notoriously even more perishable than other types of fish. They had therefore to be consumed while still fresh, e.g. even eaten alive as in the case of oysters, or in other cases boiled alive. In the nineteenth century, shrimps from some of the areas famous for them, such as Morecambe Bay, were being preserved for a relatively short period by 'potting' with spices and melted butter. The Solway Firth shrimps are treated similarly at places such as Annan to this day. At Leigh, on the Thames estuary, shrimps were kept alive in the boats' wells until taken ashore in the afternoon, boiled and sent to London by train in time for the market next morning. About 2,000 gallons a day were being treated in this way in 1874. At other places they boiled them aboard the ships as soon as they were shaken from the net.

The Orkney Islands were famous for their lobsters, even prior to 1815. They were formerly taken south alive by well-smacks, later by steamers to Aberdeen, and then railed to London, packed with seaweed in boxes to keep them alive. This was the practice in 1870 and is so to-day in the case of the outlying north-west Scottish ports, except that road transport is now employed to one of the Highland railway stations, e.g. Lairg, from such a place as Kinlochbervie, just south of Cape Wrath. Often, particularly in summer, many arrive dead and cannot be used. Crabs were and are, equally abundant, but unlike lobsters they will not remain alive during transport over the entire length of the country, so that there was in 1870 no sale for them at the outlying ports. Crayfish, however, on the Continent, are taken long distances alive.

OTHER COUNTRIES

Britain led the world in trawling in the nineteenth century and is still well in the lead. Thus Holland, which was one of the cradles of trawling, was almost static in the second quarter of the nineteenth century, at a time when the Brixham and Barking men were on the move. The number of trawlers fishing at Katwijk increased from thirty-eight in 1821 to forty-eight in 1850, but the value of the fish landed fell by more than a third.[19]

In spite of this, however, in the early eighteen-eighties, just before the application of the steam engine to the trawler, Britain's total catch of cod was still considerably less than that of some of the countries which were still relying on the baited hook (*see* Table 3) for the raw material for their industries of drying.[20] In Britain, it was still the herring industry, based on salt herring exports which accounted for the greater part of the total quantity and value of fish. The value of the British catch of salmon (£380,000) and of lobsters (£900,000) were both considerably greater than that of the 13,000 tons of cod (£140,000).

Generally speaking, other countries passed through the same course of development as Britain and for the same reasons, in the distribution of fresh fish. There are various exceptions, e.g. the tunny which it seemed possible to keep in good enough condition without ice in spite of the warmth of the water in its more southern haunts. Thus, the French *thonniers* kill the fish by piercing its brain after hooking and hauling aboard, and it is immediately cleaned, washed and sometimes even to-day merely hung up on wooden frames amidships, under a canvas awning to protect from the sun and rain.

TABLE 3. CATCH OF CERTAIN SPECIES OF FISH BY THE PRINCIPAL COUNTRIES ABOUT 1880

(Thousands of tons)

Country	*Cod*	*Herring*	*Sardines*	*Pilchards*	*Salmon*	*Misc.*
England		80			0.4	
Scotland		140			2.1	
Ireland		20			1.1	
United Kingdom	13	240		3	3.6	
Norway	110	60				
France	34	45	40			10
Canada	45	48				
Spain			52			
Russia						220*
U.S.A.						140*
Italy						100
Germany						40
Holland						20
Austria						15

*Including seals and whales

FISH DISTRIBUTION IN THE UNITED STATES

The pattern of events in the development of methods of fish preservation in the United States in the past century has been remarkably similar to that in Britain. In the middle of the nineteenth century there was still on the Atlantic coast a large production and import of salted cod, as already described in Chapter 7, and such fatty species as mackerel, which were caught in large quantities in Canadian waters, alewives, and to a lesser extent menhaden, were also preserved by hard salting and by fairly heavy smoking.[21]

In the early part of the century, halibut were regarded as a pest, like dogfish by the cod fishermen of Massachusetts Bay. A demand for this species, however, sprang up at Boston about 1825. At first the fish were merely eviscerated and thrown down on to the stone ballast or on to a platform in the hold. This practice was later improved by hanging the fish up by the tails.

In 1837, fish were brought alive to market at Boston for the first time. The vessels carried about 430 fish weighing about six tons. The fish were transported south and inland by rail.

Great care was taken to keep the halibut alive. The fishermen from New London on the Nantucket shoals carefully gaffed the fish under the lower jaw to get them on deck and then threw canvas over them on the deck and lay on top of them to hold them still, while carefully working the hooks out of their mouths, after which they were thrown into the well. When fishing from a skiff they carefully reeved a rope through the gill of each fish and towed them astern until they reached the ship, when they would be pulled on to deck with a block and tackle and then placed alive in the well.

Once a Captain Atwood of Provincetown when unable to go to these extreme lengths, clubbed the fish and threw them into the well intending to dress them later. He found, however, that they had recovered and were all alive. After that all the fish were stunned before the hook was removed and allowed to 'come round' later.

In 1880, they were still fishing for live cod off Nantucket, catching halibut as well, which were taken to New York alive. The wells were about four feet deep and were situated just for'ard of the main hatch to the main mast. About 300 holes were bored in the bottom of the ships to let in the water. A total of 16,000 to 18,000 lb. of live fish could be carried if the weather were cold, but not more than half that amount in the warm weather.

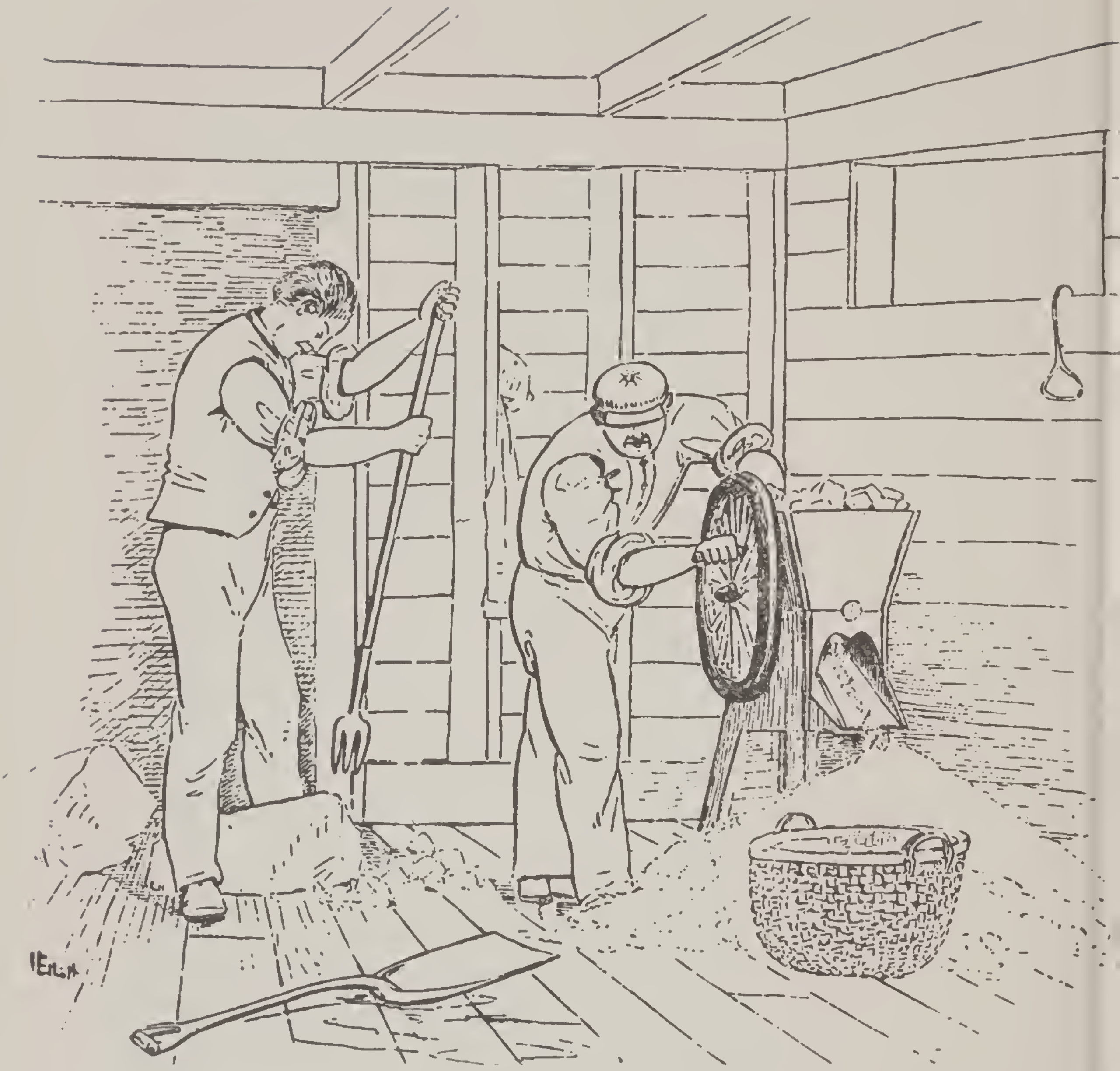
About 1838 a little ice was taken by one smack to put into the napes of such fish as might be killed accidentally. They were stowed on top of the stone ballast. By 1840, the few fish that died were being regularly iced, but only fetched 1 to 1½ cents per lb. compared with 6 to 7 cents for the live fish.

Gloucester vessels are reported to have started using ice about 1842. There was considerable prejudice against iced fish to begin with. A small amount of ice was at first stored somewhere in another part of the hold. A special ice-house was fitted up on a fishing schooner for the first time about 1846. Only about half a ton of ice was taken and the object, as in England, was to keep the fish-room cool. It was believed that contact with the ice would spoil the fish. Later, when ice was mixed with the fish thoroughly, it was claimed that they could be kept in good condition for three to five weeks. Halibut is certainly a fish of good keeping quality, but five weeks seems an exaggeration.

In 1846, the railway was completed as far as Gloucester, thus facilitating the transport of fresh fish. Within a few years, ships were carrying ice to George's Bank, just off Cape Cod, bringing back halibut and haddock.

Previous to 1858, Connecticut vessels were still taking hand-line caught halibut alive to New York. The 'line trawl' was then introduced which caught many more fish, but most of them were dead by the time they were hauled. Icing the dead fish then began to replace bringing them in alive. This fishery was carried out from 'tight-bottomed' ships and the well-smacks were plugged up to engage in this now more lucrative trade.

The Gloucester fisheries were using 25,000 tons of ice annually by 1880, mostly on board the fishing vessels, which took between six and forty tons depending on the grounds. The ice was usually cut from the ponds about Gloucester and stored in large houses erected for the purpose. During unfavourable seasons it had to be brought from a considerable distance. It was delivered to the vessels in large blocks which when required were broken up and shovelled into a crusher (*see* Fig. 14). Although ice was first used on the fishing vessels about 1845, little had been done in the way of packing fish in ice for inland



By courtesy of the Government Printing Office, Washington, D.C., U.S.

Fig. 14.—Ice crushing in fish-hold of New England liner (about 1880). *From* The Fisheries and Fishery Industries *by G. Brown Goode.*

transportation until about 1860. In that year William Oake and Seth Stockbridge of Gloucester were induced by some Boston merchants to try the experiment of sending fresh fish from Gloucester to Boston and New York, packed in ice in old sugar boxes. The experiment was successful, and a large part of the shore catch of haddock and George's Bank halibut was thereafter sent in this way by rail or steamer to Boston and other places. By 1887, 7,500 tons of iced fish, chiefly halibut, were sent away from Gloucester every year in boxes holding from 380 to 450 lb. of fish 'with sufficient crushed ice to insure their preservation', chiefly in special rail cars, for sale in New York and Philadelphia next morning. Halibut heads were sold to the oil makers, while cod fish heads were used for guano in the country districts round Gloucester.

However, the nearer grounds were exhausted of halibut by about 1850, and the fishermen had to range farther afield, even as far as Greenland, salting the halibut at sea (*see* p. 172) for subsequent smoking.

By 1879, ice was being used to preserve fresh bait for the cod fishing as an improvement on salted bait. Vessels fishing near Gloucester bought ice at home, but the Grand Bankers picked it up in Nova Scotia or Newfoundland. In nearly every hamlet, ice was preserved to sell during the fishing season. Four tons of ice was enough to preserve forty barrels of bait for fourteeen to eighteen days.

Fresh haddock from the Le Have Bank, just south of Nova Scotia, also became important in the 'eighties. They were gutted and washed, and if they were far out or the weather was warm, they were iced.

The development of the fresh fish industry necessitated faster vessels which began to be constructed in the eighteen-eighties and eighteen-nineties. As in Britain this need was met by the application of steam. Boston had a new harbour built in 1884 to facilitate speedy receipt and dispatch of the increasing quantities of fish landed fresh. However, the first trawler, the *Spray*, did not appear till 1905, and American fishermen did not take to trawling in the way that the English did. Although to-day the total United States catch is double that of Britain, only about half is used for human food and, even allowing for imports the consumption of fish per head of the population is only about one-third of that in the United Kingdom, whilst there is far greater dependence on meat, poultry, etc.[22] In addition, the long freight journeys involved in distribution and the high summer temperatures encountered have led to a much greater dependence on freezing than has hitherto proved to be necessary in the United Kingdom.

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Chapter 10

DISTRIBUTION OF FRESH FISH (II)

The Reign of Steam and Speed

EARLY ATTEMPTS AT STEAM TRAWLING

The great disadvantage of sailing trawlers was their complete dependence on the wind and weather, both for their fishing operations and the return voyage with their catch. Gales could create tremendous havoc, and 360 smacksmen and boys from Hull, Grimsby and Yarmouth were lost in The Great March Gale of 1883. Even more troublesome than adverse winds and gales were the calms during which little or no headway could be made. The latter were particularly common in summer, when it was all the more important to ensure speedy arrival of the fish on account of the high temperature, with consequent rapid meltage of ice packed round the fish.[1]

Considering that the first successful steam-propelled vessel was in use in the Clyde in 1812, it is perhaps surprising that it was not until nearly fifty years later that steam was first applied to the propulsion of a fishing vessel, and a further twenty years elapsed before the first successful British steam trawlers were launched. This was a period of experimentation, with evolution and adaptation of techniques to take full advantage of the possibilities of the new tool.

Even the laborious work of hauling nets and long lines was not lightened by the use of steam capstan and winch until about 1876, and these were not extensively adopted until the 'eighties.[2]

Grimsby's first steam liners, built by the Railway Company in 1855 (*see* p. 234), were not successful, and their engines and propellers were removed. In Grimsby in 1858, the *Corkscrew*, a 50 h.p. screw steamer of iron, built in 1844, was fitted out with a beam trawl, but the results did not seem to encourage imitators. A Hull whaler, S.S. *Diana* had steam propulsion in 1857. In Aberdeen in 1864, a small screw boat was started up as a trawler but nothing came of it.[3]

Hewetts' steam 'cutters', built in 1864 to ensure the regular arrival of the fleeters' fish at Billingsgate, had already been engaging in steam trawling, since thereby their cargoes had the advantages of being ranked as fish landed by fishing vessels. This was not, however, regarded as their regular business; the firm, as already pointed out (*see* p. 231), preferring to rely on free wind, rather than pay for steam coal.

The first successful initiative in building steam trawlers seems to have lain with France, using British yards.[4] At Bordeaux in 1864, a small wooden trawler was fitted with a steam engine. Two years later two iron steam trawlers were ordered from Govan (now Fairfield Works) and these ships were still fishing in 1912. Two more were ordered from the same yards in 1868 and three more from Glasgow, Leith, and Hull.

A steam trawler, probably belonging to Leith, was reported to have been visible from Dunbar in 1863, and next year it seems that there was a paddle-boat trawler fishing off the Irish coast. In 1870, a 77 ft. long, iron, welled smack, the *Tubal Cain*, which it was intended to fit with a steam engine, was built in Hull for Rushworth of Grimsby, and after being lengthened by 12 ft. in the eighteen-eighties ultimately became a pioneer of steam lining for live cod.

In the late eighteen-sixties at Sunderland, a small local steam paddle tug was used to pull trawling smacks over the fishing grounds when there was a long spell of summer calm. By 1877, tugs, which were being laid up with the decline in the numbers of deep sea sailing vessels visiting north-east ports, were regularly used for taking sailing trawlers down the Tyne and Wear (where coal was cheap, of course) and dragging them over the grounds when there was not enough wind. About this time at North Shields, Mr. William Purdy, tug owner, first fitted his vessel (the *Messenger* of 25 h.p. built in Jarrow in 1843) with a beam trawl with successful results in shallow water, and within two or three years there were about fifty such ships at work in the North Sea. Similar experiments were being made at Fleetwood, in 1877, and Scarborough, in 1881.

At Aberdeen, too, about 1877, a Mr. David Allen fitted out an ordinary sailing craft with an auxiliary engine and called it the *Pioneer*. He then designed a special screw steamship for fishing, the *Onward*, which, fitted up as a drifter, was taken to

Newhaven, although there was difficulty first in raising a crew and then in selling the fish. In 1881 he built two vessels for Granton owners and next year the *Kingfisher* for Aberdeen. The same year an Aberdeen syndicate purchased the *Toiler*, a 50-ton Tyne-built tug from Dublin, for £1,500 and converted it for fishing in Aberdeen Bay (*see* Fig. 15). Its first catch only amounted to three boxes of haddocks, sold to Mr. Thomas Davidson, one of the syndicate, for £1 1*s.* 7*d.* Later the crew was joined by an experienced man from Yarmouth and catches improved to such an extent that the gross revenue over the first six months was £1,772 of which £769 was profit.

THE FIRST SUCCESSFUL STEAM TRAWLERS

In 1881 the Great Grimsby and North Sea Steam Trawling Co. Ltd. was registered, and ordered two 35 h.p. vertical-engined vessels, one the *Zodiac* of 93 ft. constructed in Hull for £3,500 and the other, the *Aries* of 95 ft. in Grimsby for £3,550. These ships were launched in 1882. They caught four times as much fish as a sailing trawler and were independent of winds and calms. However, in the summer they were used mainly as carriers of fish in ice from sailing trawlers fishing off Heligoland, then a British possession. The fishing area could now be extended because steam trawlers could fish in deeper water than sailing ships, which rarely went below fifty fathoms. Later vessels had compound engines, but still used the beam trawl. Once again it took a few years to develop fishing techniques that could exploit the new tool to the fullest extent, but this time, after the several false starts spread out over the previous twenty years, steam trawling 'took on' and the change-over from sail to steam was now extremely rapid. Aberdeen's first steam trawler, the *North Star*, was launched in 1883. Next year steam trawling was introduced at Hull, and in the following year a number of fishing smacks were converted to steam. Within five years there were fifty steam trawlers there compared with 360 sailing smacks. By 1896 Hull had 200 steam trawlers and only 160 smacks, which had disappeared altogether by 1900.

In 1892, a Hull firm started steam trawling in Fleetwood, while Milford Haven had its first trawlers in 1889 and Swansea about the same time. New hake grounds were in this way opened up off the south-west of Ireland.

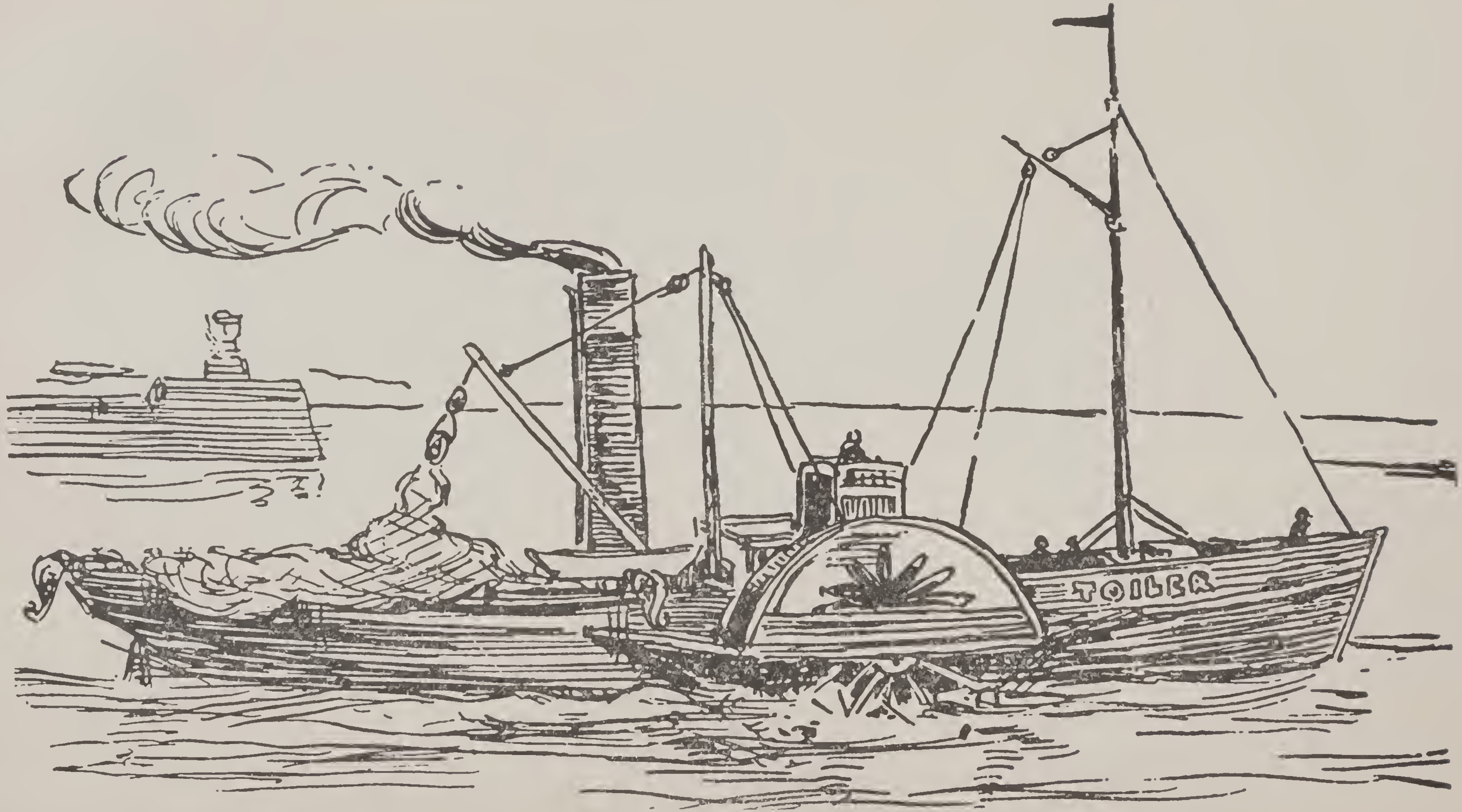


FIG. 15.—The *Toiler*, Aberdeen's first successful steam trawler.

At Grimsby, there were, in 1890, 769 sailing and thirty-five steam trawlers. Sailing trawlers however, still continued to be built, some of which, like the *Croxby*, built for Furner & Leaver in 1890, are still in existence, although now converted to diesel propulsion and belonging to other countries. However, after a March gale in 1895, which seriously reduced the Grimsby fleet, no further sailing smacks were built, and instead investment in steam trawlers was thereby accelerated. The greater capital required for the construction of steam fishing vessels led to concentration in the hands of public companies and a gradual disappearance of one-man companies and owner-skippers. By 1900, Grimsby possessed only sixty-one sailing but 471 steam vessels, and in 1909, the numbers were twenty-nine and 608 respectively.

One reason for the rapid and ready conversion to steam at the ports mentioned may have been their proximity to the coalfields of Yorkshire, Lancashire, and South Wales. However, the Consolidated Steam Trawling Co. used to bring coal from one of the smaller Durham ports (such as Warkington) where a tender could be beached, down to Lowestoft and continued to do this until about 1938 on account of the much cheaper freight rate by sea, only 3*s.* 6*d.* per ton, compared with the railway.

Perhaps the most important reason for the prominence of the northern ports was that the northern waters were more prolific in fish than the relatively restricted areas of the southern North Sea and English Channel. As a result, ports like Brixham, Ramsgate, Lowestoft and Yarmouth got left behind, and sailing smacks hung on there until quite recently. Thus, as late as 1934, sixty-five sailing trawlers were still registered at Lowestoft.

As a result of the introduction of steam trawling, there was a sudden considerable increase in the British catch and consumption of white fish. This may be illustrated by the figures for landings at Grimsby. In 1854, the first year of trawling, the figure was only 453 tons. In 1870, it was 30,000 tons; 1880, 45,000; 1890, 70,000; 1900, 135,000; 1909, 175,000. At Aberdeen, where the fishing grew up with steam trawling, the catch rose from 9,000 tons in 1887, to 18,000 in 1892; 63,000 in 1902; and 112,000 in 1911.

The quantity of fish carried from the ports by the railways rose from 285,000 tons and 93,000 tons for England and Scotland respectively in 1890 to 561,000 and 170,000 tons in 1913, an increase of practically 100 per cent.

The North Sea fleeters at Hull were replaced by steam trawlers, and at the beginning of the century, three fleets each of about fifty vessels were still engaged in direct dispatch to Billingsgate. They accounted for the bulk of the 40,000 tons, or about a million boxes, of water-borne fish out of a total of about 200,000 tons consigned annually to Billingsgate (cf. 38,000 out of 120,000 in 1880). A little was water-borne, too, to Shadwell market until about 1899.

In 1913, Hull still had 259 fleeters and cutters, comprising almost 60 per cent of the Hull tonnage. Of 222,000 tons of fish which went through Billingsgate in that year, 62,000 tons were still delivered by water direct from the North Sea. Fleeting continued at Hull after the War, although on a reduced scale, and by 1928 there were two fleets of only seventy-nine small steam trawlers including eight carriers, amounting to 20 per cent of the total tonnage, whilst 'single boaters' now numbered 193. The carriers still took fish daily to Billingsgate from the German and Danish coasts in summer and the Dogger Bank in winter.[5] The fish was carried in six-stone boxes without lids. The practice was still to pack ice not along with the fish, but between boxes, which were piled one on top of another in the hold of the carrier for convenience of transport. This trade was continued until about 1936 by Kelsall & Beeching, now entirely a Fleetwood firm. The hardships and hazards of transferring boxes of fish from trawler to carrier in bad weather have been graphically described in fictional form in *The Fleeters*.[6]

Another effect of steam trawling was that the numerous smaller fishing villages declined as the industry concentrated at the larger ports, which provided specialized ancilliary services, such as ice manufacture, boxes and nets.

A further result of the intensive exploitation of the North Sea fishing grounds by the beam trawl was that already by 1860 there were complaints of decreasing returns. These were investigated in that year by a Royal Commission, including Professor T. H. Huxley, which came to the conclusion that beam trawling was not injurious to the industry in the open sea. By the eighteen-eighties the complaints had become more persistent; another commission sat in 1883 and once again concluded that the supply of fish in the sea ought to be inexhaustible[7] and quite unaffected by man's inroads. The point at which intensive fishing becomes 'over-fishing' is a matter best decided by biologists and economists, but the practical result was for trawlers to search out new and more remote grounds. The advent of steam trawling resulted in still more intensive fishing, but also provided the way out by extending the tether.

DISTANT WATERS

As steam vessels became bigger and more powerful, and thus less dependent on weather, fishermen explored farther afield. In 1889 the Faroe Islands and Iceland banks were first fished by two steam liners out of Hull. The fish were landed in good condition, so that eight ships went there the following year and ten in 1892.

As seen in the foregoing chapters, fishing in the distant waters was no new thing for European—especially British—fishermen, who for centuries had exploited Iceland, Newfoundland and Greenland cod, fishing by hook and line, mainly for the production of salt fish. However, supplying a fresh fish market in Europe with distant-water fish required speed whilst travelling to and from the grounds and a high rate of catching during actual fishing. These requirements as to speed and catching capacity underly successive steps in the evolution of the modern steam trawler.

In 1891, the first Grimsby steam trawler prospected Icelandic waters, all but the best fish being thrown overboard. By 1894 most ships were going north where fishing was now more productive than in the North Sea.

Steam trawlers were harder on gear because, with their enhanced power, they fished bottoms rockier than those frequented by sailing trawlers. After 1895, the new otter trawl, long known to yachtsmen, was superseding the beam trawl. The original otter board, a contrivance employed by salmon poachers, consisted of a spiked board trailing in the water, which reared like an otter, attracting the salmon and impaling them. Lord Alfred Paget, who became a director of Hewetts' in 1864 (*see* p. 229), and was a keen yachtsman, may have contributed to the invention in the eighteen-eighties of a device consisting of two such boards to keep open the mouth of a net dragged behind a yacht. Its chief advantage here was that it took up less room on the deck or in the hold than the beam of a conventional trawl. However, according to Holdsworth,[8] it was already in 1874 much used by yachtsmen. The first experiments in 1885 to put this type of gear on a trawler were unsuccessful, but by 1895 Scott, of Granton, had improved and modified it so that it was rapidly adopted thereafter.[9] Robert Hewett (*see* Plate 24) attempted to patent a form of otter trawl after experiments in the Thames estuary in the late eighteen-nineties, but the application was refused.

Steel warps replaced the thick ropes in the eighteen-eighties. This new gear could only have been operated by vessels with steam propulsion and winches. Fishing was now possible down to 200 fathoms, and the fishable area was thereby considerably increased. Catches were improved by at least 30 per cent, but, after an initial increase, the yield per unit of economic effort in the home waters suffered a further decline. In 1898, the smaller steam trawlers were being sold and replaced by new vessels specially built for more distant grounds.

Steam lining off Iceland for cod, etc., and off East Greenland for halibut, with wells to keep the fish alive, was still quite thriving in Grimsby at the beginning of the century, but the ever-increasing catching power of the trawler sealed the doom of the liner for all save expensive fish such as the halibut. Aberdeen is now the chief port for steam lining, with Grimsby second. The chief haunts are still between Iceland and Greenland and the voyages sometimes as long as thirty-six days' absence from port. Fish are no longer brought back alive, but iced. In fact, cod, which do not remain in edible condition for as long as halibut, are frequently still thrown overboard when caught at the beginning of the trip. Aberdeen, by this fishing, accounts for about 2,000 tons of halibut annually, or nearly half the British catch.

By 1904, there was a large increase in the Iceland catches landed at Hull and relatively large quantities of soles had been found on new grounds off north-west Spain. Iceland fish became the basis of the salt cod drying industry of the Humber ports for export chiefly to Spain, Latin America, and the West Indies. In Aberdeen it was mainly foreign, particularly German, trawlers that supplied the cheaper, distant-water cod for drying (*see* p. 180).

About 1905 the 'White' (really the Barents) Sea was opened up again as a fishing ground for the first time since the sixteenth century (*see* p. 130), and catches there soon began to increase at the expense of the Iceland fishing.

In 1911, a Grimsby ship explored the Grand Bank off Newfoundland, which was reached in ten to eleven days' steaming. Three years later another brought back a fairly good catch from grounds between Iceland and Jan Mayen Island. The west coast of Greenland almost as far as Baffin Bay had also been fished before the first World War. Halibut and round fish were thus brought back preserved in ice after a 2,700 miles round trip. Grimsby fishermen also made an attempt to bring bring back live fish from Iceland in a specially constructed steamship with a well. The failure of this attempt sealed the doom of fish quality in this country for the next half century.

Nevertheless the expansion of the fishing area just prior to 1914, consequent upon the increase in size and range of the steam trawler, resulted in an enormous increase in the supply of cheap fish. The total landings of demersal ('white') fish increased from 330,000 tons to 420,000 tons between 1903 and 1913, although landings from the North Sea dropped from 260,000 to 170,000 tons, so that the contribution from distant waters had increased from 70,000 to 250,000 tons in ten years.

Between the wars, and since, Britain has retained the leadership in distant-water trawling. Ever more efficient methods of fishing (for example the Vigneron-Dahl trawl and its developments) and better aids to fishing and navigation (e.g. echo sounders and radar) have been evolved, and some of the largest post-war ships are 185 ft. in length and 700 gross tonnage, carrying a cargo of up to 300 tons of fish and accommodation for a crew of up to twenty-eight in some cases (*see* Plate 25). Nearly 300 ships from Hull and Grimsby now regularly visit grounds off Iceland and the Norwegian coast, and particularly Bear Island, the Barents Sea, and along the Murmansk coast where lucrative grounds were discovered in the nineteen-twenties. In summer and autumn, the south-west coast of Greenland is fished. Occasional visits are paid to grounds off Spitzenbergen, Newfoundland, and Mauretania (from Milford Haven for hake and soles) but no regular British fisheries yet exist there (*see* Fig. 16).

Germany, too, developed a large distant-water trawling industry. In 1938, they had 185 vessels and took nearly 100,000 tons of fish from north of the Arctic Circle, while in 1950, the fleet was again up to 131.

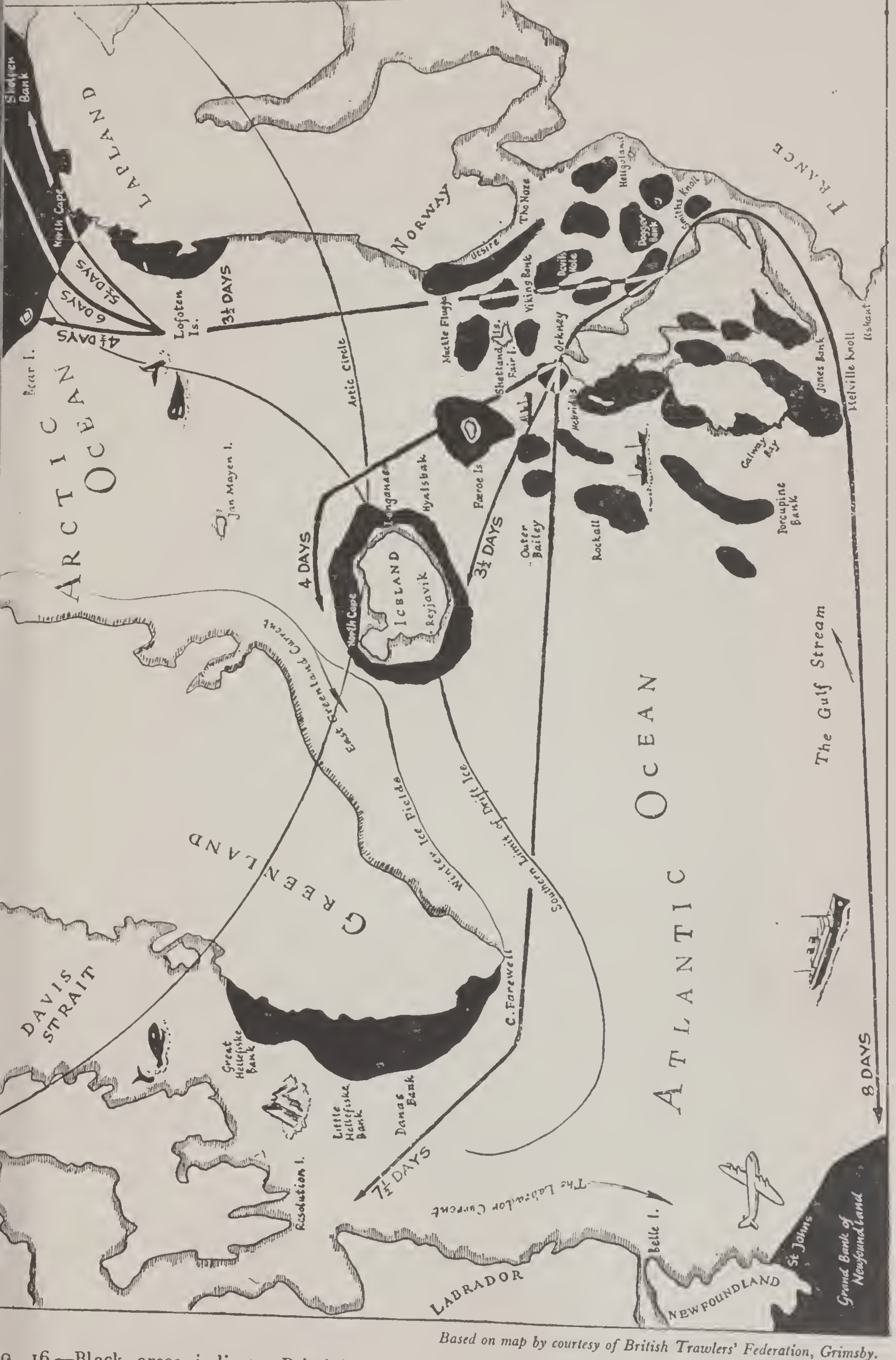
This expansion in catching power and area fished resulted in a further large increase between the wars in the quantity of white fish landed in the United Kingdom from 500,000 tons in 1913 to 850,000 tons in 1937. Much of the fish consisted of cod, the British landings of which increased steadily from 100,000 tons in 1923 to 350,000 tons in 1937, apparently without showing signs of serious overfishing in the far north.

THE QUALITY OF DISTANT-WATER FISH

As the trips lengthened, more and more ice was taken to sea, and it was more intimately mixed with the fish to keep it at ice temperature and overcome wastage, heat leakage, etc., on the journey. To-day on a distant-water trawler about one part by weight of ice is now carried for between one and two of fish: Hull and Grimsby each manufacture more than 1,000 tons per day. Such a fishery could never have been founded on natural ice, home-grown or imported.

On an average trip to-day (*see* Table 4) the ship will spend five or six days steaming to the fishing area, perhaps 1,500 miles from port, carrying, say, some 150 tons of coal or 100 tons of fuel oil and about ninety tons of ice.

The procedure when fishing is that after the trawl net is emptied, following, say, a two to four hour drag, the fish is as soon as possible sorted into species and sizes and gutted and washed in running sea-water. It is then lowered down the hatchways into the forward part of the ship which is fitted out as a fish hold, usually in two sections, in each of which there would be four to six 'pounds' or sections on each side of the ship separated by moveable boards with shelf boards at intervals to separate layers of fish. In 'bulking', a bed of ice is shovelled from the ice-pounds on to the shelves and fish is laid on this, with more ice interspersed between layers of fish and finally a layer of ice is put on top of the bulk, which may be 3 ft. deep or more



Based on map by courtesy of British Trawlers' Federation, Grimsby.

o. 16.—Black areas indicate Britain's distant water trawl-fishing grounds. (Showing average steaming times.)

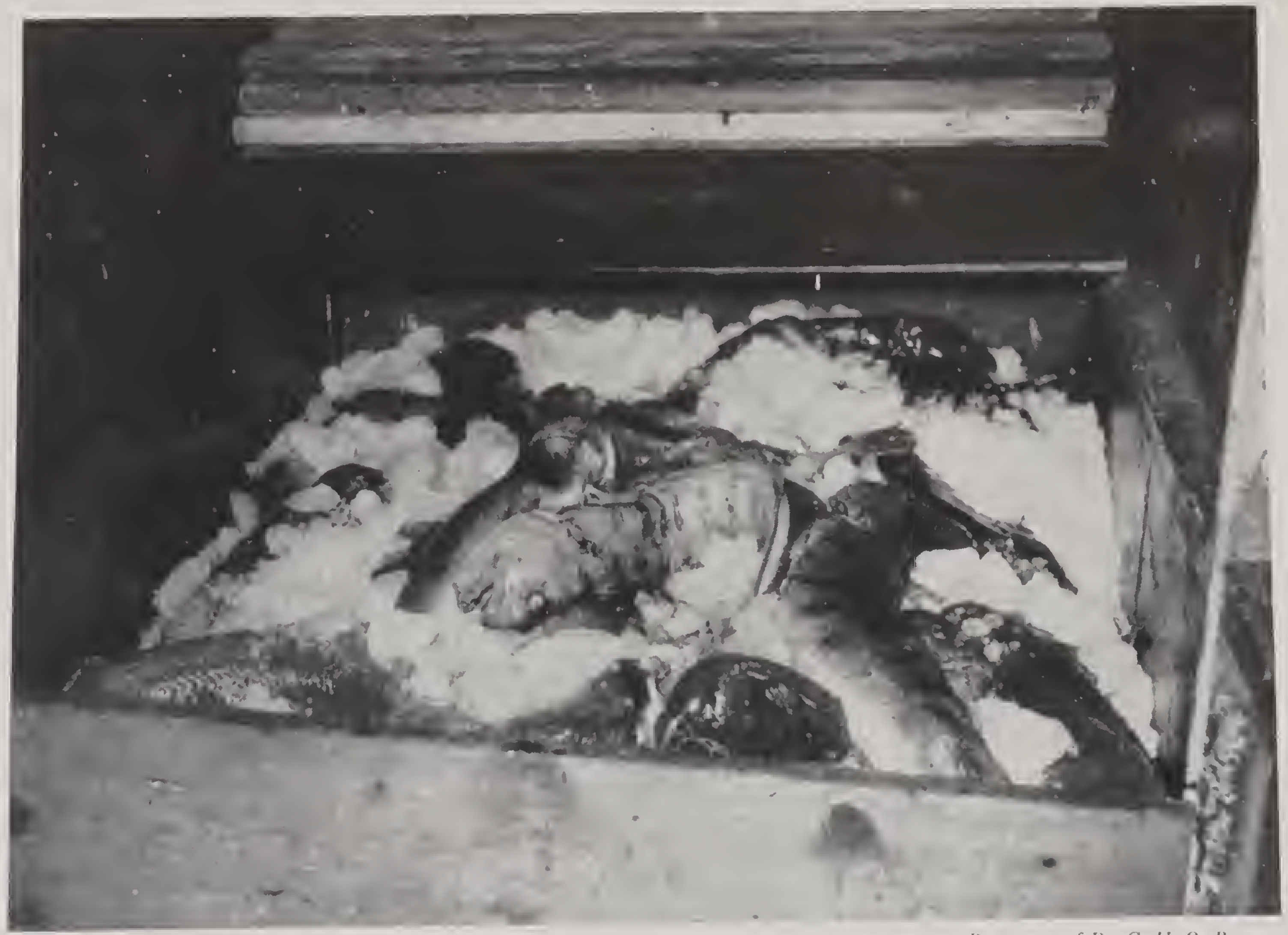
before another shelf is fitted in (*see* Plate 26). One hundred and fifty tons of fish may be disposed of in this way in the course of about ten to twelve days' fishing, sometimes less. At times, the catching rate may rise to several tons of fish per hour, and when the rate of gutting and cleaning falls too much behind the rate of catching, fishing has to stop whilst the decks are cleared. The latter part of the catch is frequently 'shelved', i.e. merely packed together on a bed of ice without being covered with ice since it is considered that the 'bloom' of the fish is thereby retained and appearance improved (*see* Plate 27).

The ice, if properly mixed with the fish, first of all reduces its temperature from that of the sea-water, which may be as high as 50° or 55° F. (10° or 13° C.) in the summer, to that of

TABLE 4. AVERAGE STEAMING AND ROUND TRIP TIME (IN DAYS) FOR BRITISH TRAWLERS, 1952

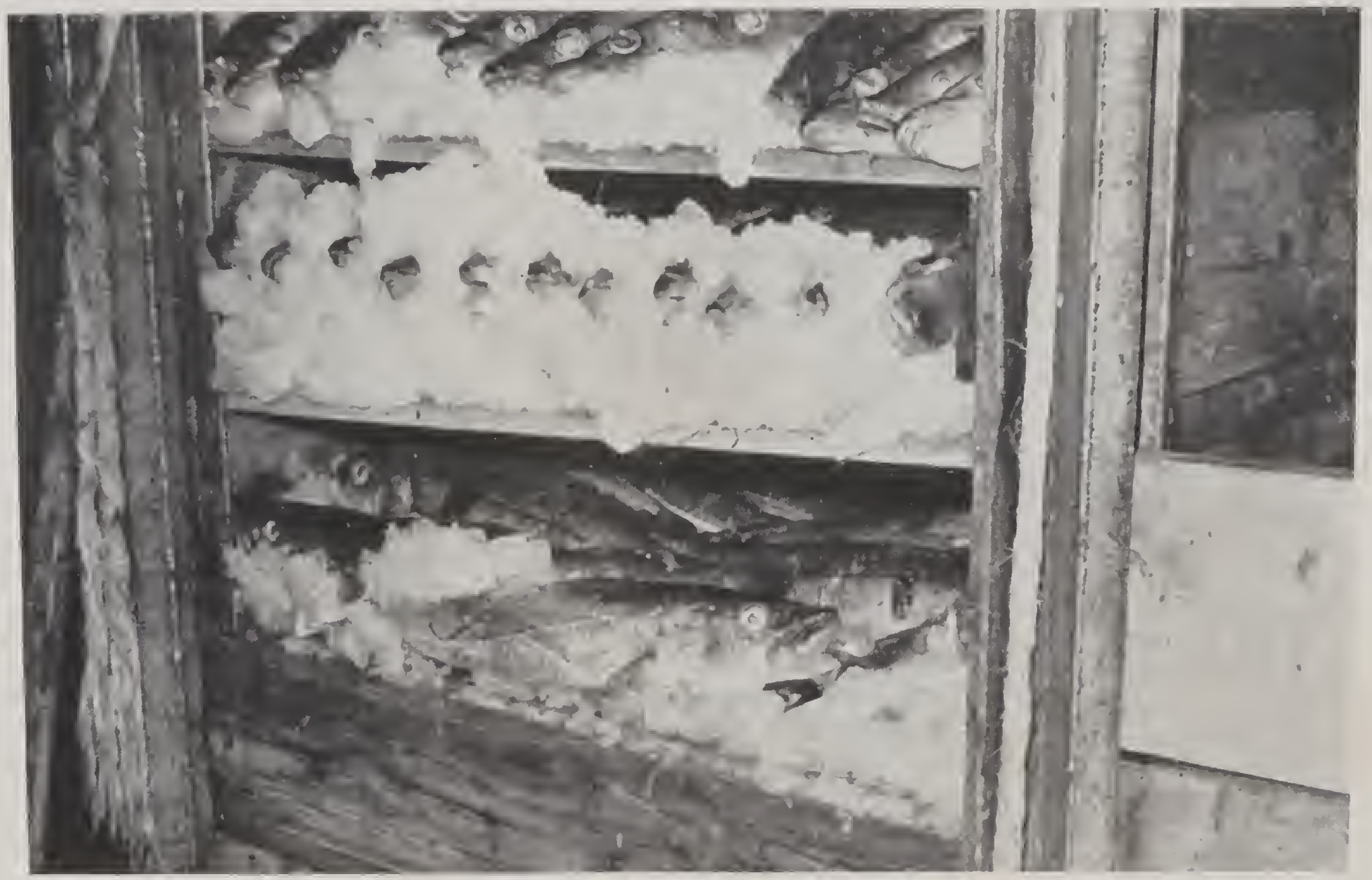
Fishing Area	*a* Average round trip	*b* Steaming time to grounds at 12 knots =age of freshest fish landed	*a–b* Average age of stalest fish landed
North Sea	8½	½–1*	8
Rockall (West of Scotland)	13	1–1½*	12
Faroes	15½	2½*	13
Iceland	19½	3½–4	16
Norwegian Coast	22	4	18
Bear Island and Spitzbergen	21	4½	16½
Barents Sea	22½	5½–6	17
West of Greenland	22½	7–8	15
Newfoundland and Labrador	24½	8–10	15½

*10 knots is assumed, since mostly smaller and older vessels.



By courtesy of Dr. G. H. O. Burgess.

PLATE 26.—Bulk-iced catfish in hold of steam trawler. Note removable 'pound boards' and ice covering which has practically all melted.



By courtesy of the Controller, H.M. Stationery Office. Crown copyright reserved.

PLATE 27.—'Shelved' cod and haddock (with dark lateral line and 'St. Peter's thumb-mark') in hold of steam trawler. Note fish regularly packed, but no ice placed on top of them.

melting ice, i.e. 32° F. (0° C.). After that it continues to melt owing to heat transferred by the air of the fishroom which would normally be at a somewhat higher temperature. In addition, heat leakage through the sides of the ship and deckhead, etc. is finally absorbed by the melting of ice. There is also some slight evolution of heat by the fish itself in the course of spoilage, particularly as it gets stale.

Most fish-rooms are wooden throughout, although a few are fitted with aluminium-lined, plastic-coated or similarly protected walls. Apart from a wood-lining and air-space between it and the side of the ship, many ships are without thermal insulation except at the bulkhead dividing the fish hold from the engine-room. Some ships have insulation such as cork or expanded rubber at the deckhead and the sides of the ship. Some fish-rooms are fitted with a small refrigeration plant with piping usually just underneath the deck.

However, the inevitable result of round trips of three and a half and sometimes even four weeks has been that gutting, washing and icing at sea as a preservative technique has been carried up to and beyond its natural limits.

As early as 1934, the Duncan Commission reported that: 'distant-water fish has brought prejudice on all classes of fish, not only because of the substitution of it for near-water fish, but because of the indifferent article that has too often been marketed.'

Speeds of trawlers have been increased to twelve knots or more, thus shortening transport time, but this has been quite insufficient to match the increase which has taken place in the distances over which fish has to be transported and the extension of the time needed by the bigger trawlers on the grounds to secure a paying load.

In order to overcome these technical problems, it was realized that their scientific basis must first be understood, and it was recommended by the Imperial Economic Committee in 1927 that a research institute be set up to investigate the field of fish preservation. As a result of this recommendation, Torry Research Station was soon afterwards set up in Aberdeen (*see* p. 10) and as a result of its work and that of similar organizations abroad, the beginnings of a deeper understanding of the causes of the spoilage of fish became possible.

The results of some of the first work carried out by Torry Research Station during the late nineteen-twenties on near- and middle-water fishing trips (i.e. North Sea, West Coast, Shetlands and Faroes) established that the deterioration of fresh fish aboard the trawler was mainly due to the multiplication of bacteria present when the fish is caught, and acquired during the process of gutting, handling and storage.[10] Ice acts as a preservative by slowing down the action of bacteria, but does not completely arrest their growth. Even with the most careful gutting and washing to remove all pieces of membrane liable to hasten decomposition, combined with careful handling to avoid bruising, followed by adequate chilling in ice, fish does not keep really fresh for more than about six days. From the sixth to the twelfth day, signs of spoilage develop, affecting the appearance, odour and firmness of the fish. In the next phase between the twelfth and sixteenth days, spoilage develops rapidly and after the sixteenth day the fish soon becomes putrid. It was demonstrated, too, that improved care and hygiene were necessary if fish caught under commercial conditions was to keep even as well as this.

Post World War II experiments on the keeping properties of fish from distant waters, using careful sensory methods of inspection as well as chemical and bacteriological analysis, have not significantly altered this picture.[11]

As Table 4 shows, a fair proportion of the catch from most of the distant-water trawlers is sixteen days old or even older by the time of landing. In addition, by no means all the fish is subjected to the perfect treatment of gutting, washing and icing to which the previous figures apply. Recent surveys and experiments have indicated the relative importance of the various factors causing deterioration at a faster rate, and this has permitted a rough estimate of the proportion of the fish landed which suffers in this way.

Since the spoilage of fish is due primarily to bacteria, and to a less important extent to enzymes, both of which are more active the higher the *temperature*, this factor is the most important single item affecting quality at any given time after catching. The lower the temperature, the slower is the deterioration. The lowest temperature that can normally be reached by fish kept in contact with melting ice is 32° F. (0° C.). However, recent evidence suggests that the fish on distant water trawlers may actually be landed at a temperature of between 30° and 31° F. (−1° and −9.5° C.) possibly owing to the presence with the ice of blood, salts, sea-water, etc., resulting in a slight depression in the melting point. Bacteriological evidence suggests that a difference of one or two degrees Fahrenheit in this zone may have an effect of appreciable importance on keeping quality. It has also been established that at 42° F. cod spoil about two and a half times as fast as they do at 32° F. in ice. Delays in gutting, icing, and stowing fish which sometimes occur during heavy catches therefore result in reduced quality: so does any rise in temperature, for whatever reason, on the homeward journey. Experiments on ships with uninsulated fish-rooms on a normal three-weeks' trip to Arctic waters in summer, showed that fish stowed close to the ship's side may sometimes rise, through wastage of ice, from 35° to 52° F. (2° to 11° C.) during the last four to six days of the trip. As a result, fish which had been caught only ten days had a quality equal to that of fish properly iced all the time for sixteen to eighteen days. This unnecessary loss of quality was prevented on a ship with an insulated fish-room, but could also be avoided in the normal fish-room by suitable deployment of ice, particularly at the ship's side. Fish at the top of the stowage also tended to become denuded of ice, particularly in uninsulated, non-refrigerated fish-rooms unless special care was taken.

From all the data obtained, it has been concluded that on uninsulated vessels possibly 5 to 10 per cent of the catch is normally landed in warmer weather from three to six days less fresh than fish kept properly chilled. Refrigeration grids as at present employed are only of limited use in precooling the fish-room before fishing starts, and in absorbing heat inleak through the deckhead; they cannot influence temperature conditions within the general mass of fish or at the ship's side. Efficient gutting and washing of the fish are also essential for good keeping quality.

As a result of the earlier British work on near- and middle-water trawlers, suggestions were made for more hygienic handling and stowage.[10] In recent years more attention has been paid to these recommendations and aluminium- and plastic-lined fish-rooms used on some distant water trawlers should facilitate improvements in hygiene. Recently a Hull trawler skipper has devised a simple and convenient form of washing machine which permits continuous washing of the fish as soon as they are gutted. It seems quite possible that this form of fish washer, which has been quite widely adopted in Hull, may result in a somewhat cleaner product than the usual rather perfunctory washing the fish received by the previous procedure.

Stowage of fish to a depth of 3 ft. or more also affects the quality, particularly as regards appearance on which, more than anything else, the sale price of the fish depends. In addition, the underneath fish suffer a loss of weight owing to the pressure causing juice to exude, to an extent which increases with the staleness of the fish and can amount to about 14 per cent in the case of cod and haddock after eighteen days. Protein and flavouring substances are also lost in the juice: shallower stowage reduces this loss. However, commercial 'shelving' on a bed of ice as previously described, although apparently yielding a more attractive appearance also results in a more rapid deterioration than normal 'bulking'. Such fish goes sour more quickly than bulked fish, and for this reason only the latter part of the catch is usually shelved in this way. This difference is due chiefly to the fact that the temperature of the shelved fish is intermediate between that of melting ice (namely 32° F.) and that of the fish-room, which is usually above freezing point. It is also quite widely believed that the washing effect of melting ice running over the fish may be beneficial.

Fish iced and put into boxes at sea actually lose no weight at all, and are superior in appearance and general quality to bulked fish. This practice has been recommended for the near- and middle-water white fishery, and has for many years been used by the Granton trawlers and more recently by some of the Danish and Swedish seine-net vessels which land fish in Britain. Granton trawlers, fishing mainly the near and middle waters, developed a characteristic type of eight-stone box with hinged lid, in which fish are distributed directly to Edinburgh and Glasgow. Larger trawlers carry 400 to 500 boxes, and smaller ones only 100 to 200. Normally, two stones of ice was put in along with six stones of fish, although on long voyages in summer this was found to be inadequate.

Another method of packing not yet practised in this country is the use of a non-returnable box. Between the wars, Boulogne trawlers used this procedure, weighing and packing 27 kg. (59½ lb.) of fish with ice and parchment paper and nailing the lids on. A trawler would carry 450 to 600 of these boxes, one on top of another (i.e. only about twenty tons), a small catch by distant-water standards. On long voyages, the lower boxes were re-iced by shifting the upper ones piecemeal—a laborious procedure. Torry Research Station in 1928 found that the quality of fish was best preserved in middle-water trips by placing three stones of ice along with four stones of fish in a non-returnable box. However, the quantities of fish involved on the distant grounds and the general conditions of work, make it extremely doubtful whether such practice could ever be applied to the main section of the white fishing industry. Even with the best treatment, only a small proportion of 'really fresh' fish (less than six days old) can be landed at British ports from distant waters, and unless trips are curtailed to, say, seventeen days, much fish landed cannot help being in the third phase of rapid spoilage (*see* p. 262). Thus, in spite of the work that has been done in the past twenty-five years, the situation to-day is, if anything, worse.

During the twelve months ending 31st March, 1952, out of a total of 617,000 tons of white fish (excluding shellfish) landed in England and Wales, and 159,000 tons in Scotland, 57.7 per cent came from distant waters, 30 per cent from near and middle waters, and 9.3 per cent was caught 'inshore'.[12] In 1951, imports represented 15.1 per cent of the total supplies of white fish. Several thousand tons annually, amounting to between one and two per cent of the white fish landed from distant waters, which now account for more than half our landings, is condemned at the market as unfit for human consumption and much of the remainder is so mediocre in quality that large quantities of fish, chiefly at Hull and Grimsby, are classified on the market as 'edible unsold', and are, like the condemned fish, converted mostly into animal feeding meal. This category amounted to just over 20,000 tons in 1953, of which Hull alone had about two-thirds. The reason for this is partly the indifferent quality of a fair proportion of the catch, and partly reluctance to selling fish at a price below its economic cost. A further proportion is condemned at the inland wholesale market. At Billingsgate, for example, which handles some 150,000 tons of fish every year, the 'fish meters' of the Worshipful Company of Fishmongers have been regularly condemning between ½ and 1 per cent during the post-war years.

Of the larger fishing ports, really fresh fish preponderates only at Aberdeen, where trawling has continued to be based on the North Sea, West Coast and Faroe fishing grounds, although as already mentioned, steam and motor liners often visit the east coast of Greenland for halibut, and at Lowestoft, which fishes only the North Sea.

There has been a decline not only in the proportion but also in the quantity of fish from nearer waters as they have become more difficult to get. Thus, landings at Aberdeen fell slightly from 95,000 to 75,000 tons between 1913 and 1937, despite constant improvements in fishing gear and methods.

Grimsby still has a considerable North Sea fleet, but Hull now outstripping Grimsby in quantity landed, has concentrated almost entirely on the distant waters. In 1913, the Hull landings amounted to 70,000 tons. By 1930, however, over a quarter of a million tons of fish were landed at Hull, of which 180,000 tons were dispatched by rail, and in 1937 the total had risen to 320,000 tons, the greater amount being filleted.

The rise of filleting, in which the flesh is cut away from the bones, head, etc., was associated with the increase in the quantities of distant-water fish. Fish was first filleted on an extensive scale at Hull in 1926. Apart from removing the unsavoury appearance of the head and skin in staleish fish, it also resulted in a reduction of transport charges by more than a half, and a centralization of offal collection for fish meal manufacture, besides presenting fish to the consumer in completely edible form.

Partly as a result of the influx of poor quality cod, there was a slump in the white fish trade in the nineteen-thirties which was accentuated by the 'economic blizzard' then raging. It was found necessary to apply some restriction to catches in order to maintain 'economic' prices, and with occasional intermissions this situation is still with us.

The most important factor determining fish quality is length of trip (*see* Table 4). Calculations have been made of the average length of a distant-water voyage from year to year since the mid-nineteen-twenties. Although there are obvious objections to taking one over-all annual average in this way, nevertheless the figures suggest some significant trends. From 1925 to 1938 this average varied only within narrow limits between 19½ and 20½ days. During the immediate post-war years, 1945 to 1949, when price controls encouraged maximum landings, it was very close to 23 days. Between 1950 and 1952 there was an improvement and the round trip time was practically constant at 21¼ days, which was still a day or two longer than pre-war average. In 1953, however, the figure for average day's absence from port fell to just below 20 days again, largely owing to a two-thirds increase in the catch from the nearer, Icelandic grounds, which accounted for just over half the landings, at the expense chiefly of the Barents Sea. The fact that trawlers can now steam faster than they did in the nineteen-twenties means that, for a given round trip time, not only is the last-caught fish a day or so fresher on landing, but in addition the first-caught fish is that much staler. Allowing average time for the voyage back from the fishing grounds it will be seen that some of the fish on an average trip is 16 days in ice by the time it is landed, and therefore perilously near the borderline of acceptability, however carefully it is handled and iced on board the trawler.

MARKETING AND INLAND DISTRIBUTION

Once the fish has been landed it has to be marketed and distributed by rail or road before it can be retailed. Although the fish industry is based on expeditious handling, this chain may involve a further twenty-four to forty-eight hours delay before actual consumption. Recent surveys have indicated the order of magnitude of the deterioration involved in distribution, bearing in mind that temperature is still the most important factor determining rate of deterioration.

In the first place, the trawler itself may be exposed to warm dock-water for a day or more before unloading. Unloading usually commences in the early hours of the morning, and the fish are exposed without ice on the market floor or in wooden or metal kits for some seven to ten hours before being sold and removed from the market, by which time the temperature is frequently above 40° F. (4° C.) and occasionally above 50° F.

(10° C.).[13] At 42° F. (5° C.) the rate of spoilage is over twice as fast as it is at 32° F., and at 52° F. (11° C.) it is about four times.

If the fish are to be dispatched the same day, it is unusual even to cool them before packing. They are packed in wooden boxes with ice, usually 20 to 30 lb. per 5-stones (70 lb.) of fish in summer, although 6 stones of fish and correspondingly less ice is used in the winter. Since the fish when packed is often at a temperature of 50° F. (10° C.) or higher in the case of fillets, a considerable proportion of the ice is melted rapidly in cooling the fish and the box. The fish may take from one to four hours to cool depending on its thickness. Thus a 3-lb. cod, completely surrounded with ice, takes about two hours to cool from 60° to 32° F. (15.5° to 0° C.), a 7-lb. cod, three hours, and single fillets an hour or even less. Since 12 lb. of ice is required to melt in order to cool 70 lb. of fish through this interval, it would be expected that one-half to one-third of the ice present will melt in the first three hours, thus diminishing subsequent protection against warming-up during transport.

It has been observed that the temperature of fish in transit in rail vans rarely rises above freezing point for periods of up to twelve hours, even in summer, but exposure of the boxes to the sun on the station platform for a few hours removes practically all the ice, with resultant rise in temperature and accelerated deterioration. Ice is sometimes shovelled on top of the pile of boxes in a rail van to cool the air in the van, and thus reduce ice wastage in the boxes themselves. Various improved forms of box with metal or plastic lining are coming into use, which are more hygienic than the plain wooden box, but the ideal non-returnable box has yet to be found. About 15 million boxes each containing up to six stones of fish are dispatched from the ports annually, although, of course, the majority of these are returned to be used over again several times.

Fish from the two Humber ports is distributed chiefly by railway to industrial centres all over England.

FRESH FISH IN WESTERN EUROPE

Perhaps Britain is, next to Japan, the largest fish-producing and fish-eating country in the world. It was the pioneer of trawling and still leads the world in this industry. The situation in the rest of Europe is diverse. At one end of the scale, live fish can still be purchased at the fish market, e.g. freshwater fish in parts of Russia and cod at Bergen, where freshly killed and cooked it is still regarded as the greatest fish delicacy. At one time between the wars, these fish were sent by rail to Oslo in special tanks. However, their condition on arrival was often so poor that the practice died out in favour of proper icing. At the other end it can be seen that Britain is not alone in the difficulties she faces in marketing fish of satisfactory quality. A similar situation seems to be general throughout Western Europe. A report by the Organization for European Economic Co-operation in 1951[14] stated that of the 400,000 tons of white fish originating annually north of the Arctic Circle, at least 50 per cent and maybe 70 per cent of the total quantity of fish marketed in the fresh condition is more than two weeks old. As in the United Kingdom, cooling facilities, handling, stowage and transport generally, are far from perfect, so that the major part of the fresh fish marketed is in very poor condition.

Denmark is singled out for special praise in its care in handling fish for export, albeit mostly North Sea fish, of course, in which the problems of handling are far less acute than in the case of a distant-water fishery. Most of it is either landed live or boxed and iced on board. However, it is worth noting that the high standard of Danish fish is probably one of the main factors which have enabled Denmark to find an outlet abroad for its increased production. The reasons contributing to this high standard of quality are apparently education of fishermen and exporters, proper transport equipment, and governmental control.

Generally speaking, the factors which contributed to the general poor quality of fish marketed in Western Europe were lack of adequate landing, harbour, and inland transport facilities. Germany was a notable exception in having up-to-date equipment, and Denmark had an important fleet of refrigerated trucks. Retailing of fish in shops was found to be of very variable standard. There were 'some excellent retail shops where modern equipment for display and storing was available.' However, in the same localities, were found others which were likely to bring the whole trade into disrepute.

In Germany they were somewhat perturbed by the way in which fish was being unloaded by the trawlers. On discharging the cargo, hooks are used when the fish is sorted, as it is placed in boxes for auction and the effect shows up later during transport and distribution. This may to some extent negate the good landing installations with which it is credited. Some countries have enforced regulations forbidding such reprehensible practices as the use of hooks, and others relating to insufficient cleanliness. In this connexion, training of the personnel engaged in the industry was also judged to be of importance, 'since many of the mistakes made are merely due to ignorance of the main factors affecting quality.' The conclusion is therefore reached that 'the lack of sufficiently good quality is possibly the most important factor hampering fish consumption in Europe.'

ATTEMPTS TO IMPROVE ON ICING

Ever since the success of canning there have been various attempts to apply modern scientific knowledge and engineering equipment to the betterment of fish, not always with a thorough appreciation of the principles involved. Thus in 1884 'a small zinc apparatus' was exhibited 'for ejecting all air' from a bin containing herrings, 'after which pressure was applied', quite to what purpose was obviously not understood.[15] The process, which was due to a Mr. Zwierchowski, of Paris, was described as 'ingenious and economical' but 'not likely to become practical'. The addition of artificial antiseptics, as against the 'natural' ones like salt and smoke, was no doubt suggested as a result of Pasteur's appreciation of the microbiological nature of food spoilage and infection followed by Lister's attempt to eradicate sepsis during surgery by sprays of carbolic acid and other similar products of coal tar chemistry. The same writer then goes on to mention that 'Mr. Peter Johnstone, of Point Law, Aberdeen, is presently making experiments with the antiseptic powder, and finds it very satisfactory for preserving salmon and all kinds of fish. As the Norwegians have practised this process for some time and have proved the fish to have been delivered in the English markets in a wholesome condition two months after catch' a great future was expected of it. Unfortunately, chemicals which suppress bacterial activity are all too often toxic when taken in the quantities that are necessary for successful preservation, and their use if permitted at all by our Food and Drugs Act, is closely circumscribed so as to protect the consumer. Similarly attempts to introduce antiseptics into ice in which fish is cooled have for various reasons not produced encouraging results,[16] although it is reported that they have been used in the United States and Germany.[17] The same applies to the storage of iced fish in an atmosphere containing carbon dioxide.[18] Although this 'gas storage' has proved effective in extending the keeping quality during distribution in the case of fruits and meat the improvement noticed in the case of fish was not sufficiently remarkable to justify its adoption on trawlers at sea.

It can be concluded from the foregoing that, generally speaking, no improvements or innovations within existing technical limitations could result in a vast increase in the quality of the fish landed. Only a revolutionary change will suffice, as far-reaching as the new processing chain for salting herring attributed to Beukels in the fourteenth century, or as the use of ice initiated in this country by Hewett in the nineteenth century. For many, this leap is believed to be freezing. Already the basis is there, just as perhaps the Hanseatics prepared the way for Beukels and Dempster for Hewett. When the technical and economic conditions are ripe for freezing fish at sea on the fishing grounds (*see* Chapter 12), the preservation of fresh white fish during distribution will have been brought finally under control.

STEAM DRIFTING

It was not long after steam trawling had proved itself that steam was applied to the herring drifter. Elliot and Garrod of Beccles seem to have introduced a steam capstan for hauling the nets of sailing drifters about 1884. Steam was taken up the centre of a hollow capstan to an engine at the top, thus saving half the fuel used by the earlier models.

The first steam drifter was built at Lowestoft in 1897 and was an immediate success, making twice the catch with the same spread of nets. Some of the earlier steam drifters had very little steam power. Thus, one built at Lowestoft in 1900 for a Hull firm had an auxiliary engine of only 15 h.p.[19] However, by 1901, the steam-drifter was beginning to make its presence felt, and large numbers were built in the early years of the century, particularly between 1905 and 1910, although sailing drifters continued to fish, albeit in decreasing numbers, up till 1914. The Scottish ports also went over to steam. At Peterhead in 1890, the catch was about 27,000 tons (*see* p. 106) and there were 535 sailing boats. By 1907, there were 124 steam vessels compared with 199 sailing vessels, and the catch was doubled. The combined annual catch of England and Scotland, which was about 250,000 tons between 1886 and 1900, rose to 400,000 tons between 1902 and 1905, and continued to increase, reaching nearly 600,000 tons in 1913. Owing largely to the disruption in the export trade of salt cured herring resulting from two world wars, the catch in recent decades has rarely even approached half of this peak figure.

Steam drifting did not pose any new problems in the preservation of the herring in the way that steam trawling did in the case of white fish. The reason for this seems to be that the migratory shoals of herrings which occur off our coasts at—within limits—regular times, did not appear to be affected by the increased fishing, whereas on the other hand, the bottom fauna of the North Sea was soon so seriously depleted by the steam trawlers that they had to go much farther afield for their supplies. As a result, the herring fishery continued to be based on over-night trips just off shore and therefore obtained full advantage of the increased certainty and speed of the voyage homeward with the catch. For this reason, the average freshness of the herring landed was probably improved, and the practice of adding a sprinkling of salt to the catch, common in 1870,[20] disappeared. The fish are too small and numerous to gut at sea, and ice was not until recently considered to be necessary in such short trips.

As in the case of trawlers, the present tendency is to experiment with the application to the drifter of the diesel engine, which is more economic of fuel than the steam engine, but demands more skilled attention. The diesel engine has been applied with considerable success to the smaller type of dual purpose white fish seiner-drifter particularly favoured in Scotland; and in the larger class of vessel the same firm of Catchpole of Lowestoft which was one of the first to pioneer with the steam drifter, has now in 1952 built a 300 h.p. 3-cylinder diesel drifter.

The enormous increase in the Norwegian catch of herring since 1945 is at least partly due to improved methods of locating and catching fish made possible by echo-sounding, ring netting, etc.

The quality of herrings reaching the consumer depends partly on their biological condition, related to their fat content which rises from a few per cent to over 20 per cent and then falls again during the spawning cycle; and partly on the deterioration suffered after catching, which is accentuated in the summer by warm weather and 'feedy' fish which have their guts full of food and are therefore particularly perishable.

In the hold of the average 80-ft. steam drifter, which will carry one hundred crans (about 20 tons) fairly easily, and even two or three times as much in the case of occasional heavy catches, little attempt is made to break vertical pressure in stowage, apart from horizontal shelving normally used to divide the pound in two. A depth of three to four feet in stowage is fairly common, which causes considerable damage to soft, oily, uneviscerated fish. Experimental work has shown that although careful handling and cleanliness are not negligible factors in determining the final quality of fresh herring, the temperature of the fish is of overriding importance. A great improvement in quality would result if thorough chilling with ice were applied all the way along the distribution line from catching to cooking.

It is still not generally regarded as necessary to ice British herrings aboard the drifter, perhaps because of the shortness of the over-night fishing voyage, although adoption of such a practice would undoubtedly result in a considerable improvement in quality.

An increasing proportion of the boats now carries wooden or aluminium boxes of about one-sixth-cran (65 lb.) capacity in which part of the catch—or all of it, if it is a small one—is stowed, often with some ice.[21] On arrival at the port, fish stowed in boxes are landed and sold in them, although the boxes are returnable and the fish have to be repacked for transport. The normal 'bulked' catch is landed a quarter-cran at a time on the market, by baskets, which are emptied into boxes, etc., in which they are then dispatched after further icing.

This icing on shore is, however, usually inadequate especially in summer to reduce the temperature of the fish to 32° F. (0° C.) and keep it there during transport, which would require a ratio of about one part by weight of ice to two of fish.[22,23] One firm, however, has developed a catching and distribution chain with aluminium boxes containing iced herring, taken straight from the drifter and put into insulated, aluminium-lined road vehicles, in which they are taken even from north-east Scotland in summer as far as the south of England, in fairly good and certainly in improved condition, even if they are not always, owing to the delay, really first class on arrival.

Cooling rail vans with solid carbon dioxide ('dry ice') is also claimed to result in an improvement in quality of Scottish herring reaching London. Since the effect must be one of cooling only, because carbon dioxide gas in the concentration of a few per cent only likely to be built up, has no particular preservative effect under these conditions, it seems probable that the same improvement in quality could be obtained with much less cost by the more liberal use of ice.

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Chapter 11

THE DEVELOPMENT OF MILDLY SMOKED FISH

JUST as trawlers and railways in the middle of the nineteenth century made it possible for the first time to satisfy the demand for fresh fish in preference to the dried and salted fish available up till then, so also, for the same reasons, there were, in the same period, changes in the taste for smoked fish, again brought about chiefly by quick railway transport. From that time onward, the more durable types of products, such as red herrings, have gradually dropped out of the normal household budget along with salt cod, etc. Apart from a minute home outlet in *hors d'œuvres* and 'bloater' pastes, 'reds' are now mostly exported to the traditional markets in Mediterranean countries and the Levant, a trade into which Holland also enters (*see* p. 79).

BLOATERS AND KIPPERS

The 'Yarmouth bloater' (*see* Plate 28), perhaps one of the earliest of these new mild smoke-cures, was first produced, accidentally it is related, by a Mr. Bishop, about 1835,[1] and within ten years *The Times* was using the term as a familiar epithet for the inhabitants of that town, although this was possibly due to the equally strong association with the earlier product. It is produced from whole, ungutted herring by first salting lightly. Originally the 'rousing' the fish used to get in the well of the sailing drifter was sufficient. Later, when this practice ceased, fresh herring would be kept in salt over-night, for say twelve to eighteen hours.[2] About 5 or 6 per cent of the weight of the fish is lost in the form of liquor extracted from the fish which runs away as brine. About 2 or 3 per cent of salt by weight is picked up by the fish in the process. It is then subjected to a mild smoking treatment in a kiln of the type already described for 'red herrings'. Billets of hard wood are used to give flames and heat rather than a dense smoke. The fish loses a further 5 or 6 per cent by evaporation of moisture

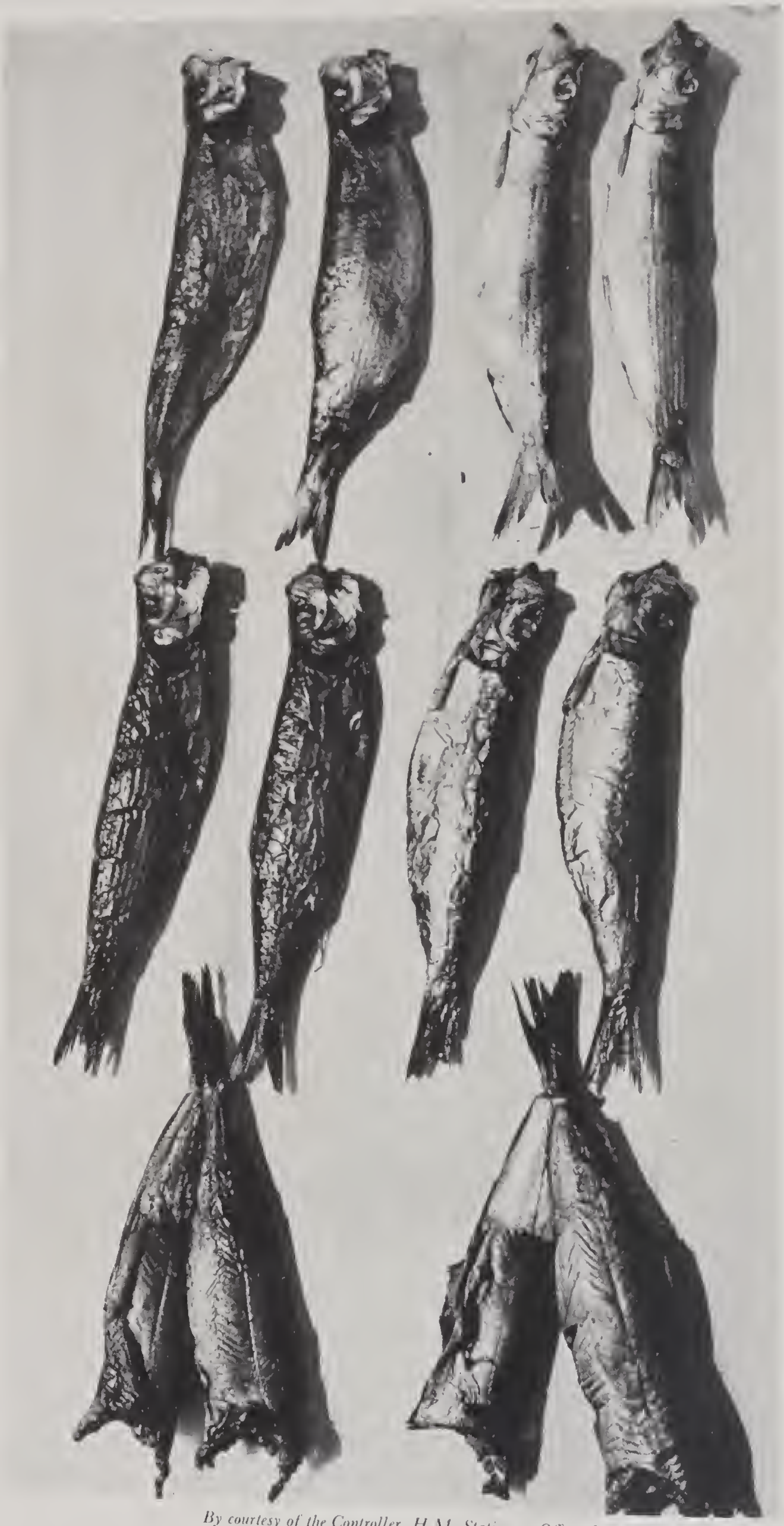

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PLATE 28.—Mild, round smoke cures. *Top.* Yarmouth bloaters. *Centre.* Bucklings. *Bottom.* Arbroath smokies.

and takes on a mild smoky flavour, but practically no colour, so that the skin remains silvery in appearance. The rather characteristic, 'gamey' flavour that this cure acquires is in part due to the fact that the fish is not eviscerated. The product, however, cannot be transported long distances and is at its best when eaten whilst still perfectly fresh at the port where it is made (i.e. usually Lowestoft or Yarmouth). The product sometimes made by merely wind drying herrings in fishmongers' shops inland is, naturally, inferior by comparison with fresh fish oak-smoked at these ports.

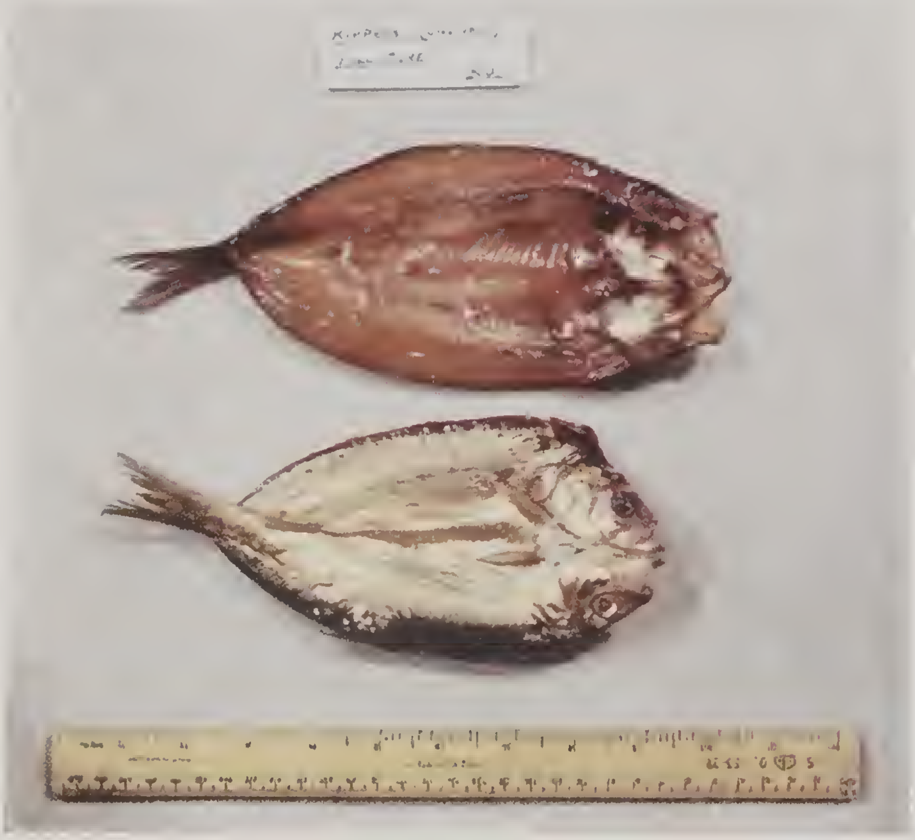
Very few 'Yarmouth bloaters' are produced in Scotland, where the term 'bloater' is still used mostly for the less smoky species of 'red' (*see* p. 78). Whilst it is true that the less fatty herrings caught in the East Anglian season are especially suitable for bloatering, as for 'redding', nevertheless there is a class of herring caught in July off north-east Scotland, for example, which would be eminently suitable for the preparation of this delectable, though perishable, product.

By 1843, the 'kipper', or 'Newcastle kipper' as it was first called, had been deliberately invented by John Woodger at Seahouses on the Northumberland coast after several years of experiment, and was first sent to London in 1846, since when it has grown to be one of the principal home outlets for herrings (*see* Plate 29a).[3] 'Kippered' salmon had long been known (*see* p. 84). Woodger transferred the epithet to the herring smoked over-night after splitting down the back, removing the guts and gills and lightly salting, originally in solid salt.

Nowadays, the fish are salted by twenty to thirty minutes immersion in 80 per cent saturated brine, the time depending on the size and fattiness of the herring. This results in an uptake of about 3 per cent of salt in the final product, which is just about right for palatability, although it does not at this concentration contribute significantly to keeping quality. However, the immersion in strong brine also forms a sticky solution of protein on the cut flesh surface of the fish which when dried in the smoke forms a tough, glossy, attractive looking 'pellicle'. The brined fish are stretched on 'tenter hooks' protruding from the 'tenter-sticks' (the terminology comes from the textile industry) which are hung up in a brick-built smoking kiln[4] with fires on the floor and smoked for anything from six to eighteen hours, depending on their position in the kiln (*see* Plates 30 and 31). A 'nightsmoker' takes out the bottom fish when he judges them to be finished and moves down the top fish closer to the fires until they are 'done' and so on, a process known as 'stripping' the kiln. The loss of weight due to evaporation of moisture in this process is about 20 per cent for a cure that will keep in good condition for up to a week at ordinary temperatures, which is quite adequate for distribution and consumption. If kept much longer than this the fat tends to become rather rancid to the taste, and moulds, which are inhibited by the antiseptics absorbed from the smoke, begin to develop. The kipper did not, of course, displace the 'red' herring in Scotland until the arrival of the railway permitted it. A book on the Scottish fisheries published in 1849[5] mentions only 'reds' of which two grades were produced, a mild cure smoked for only about thirty hours for London and the southern markets of England, and a heavier cure, more like the traditional product, smoked for three weeks for home use during the winter. By 1885,[6] however, kippers were being produced in Scotland 'for more immediate consumption', although it is remarked that 'bloaters will keep for a longer time than kippers.' Most probably these 'bloaters' were, in fact, the mildly smoked 'reds' just mentioned, and certainly nothing like 'Yarmouth bloaters'. Even at this time, kippering was still a local 'art'. Women from the Northumberland coast were still chiefly employed as 'cutters', i.e. for splitting the herring, and used to follow the herring fishing round the country much as the Scots 'fisher lasses' do in the herring curing to this day. Their menfolk, too, were skilled in the smoking of herring and in particular had to be able to remove the finished fish from the kiln whilst smoke was rising from the fires. Woodger himself later settled in Yarmouth and the firm still continues under his name, although since absorbed in a larger concern, namely MacFisheries, a subsidiary of Unilevers'.

SMOKED HADDOCKS

The smoking of white fish, too, evolved in a similar direction to meet the needs of the times. Already before the advent of the railway the hard, salty, chimney-smoked, peat cure ('findrums' of earlier times, *see* p. 168) was being modified in the first quar-



(a)

PLATE 29.—(a) Undyed kipper. (b) Finnan haddock.

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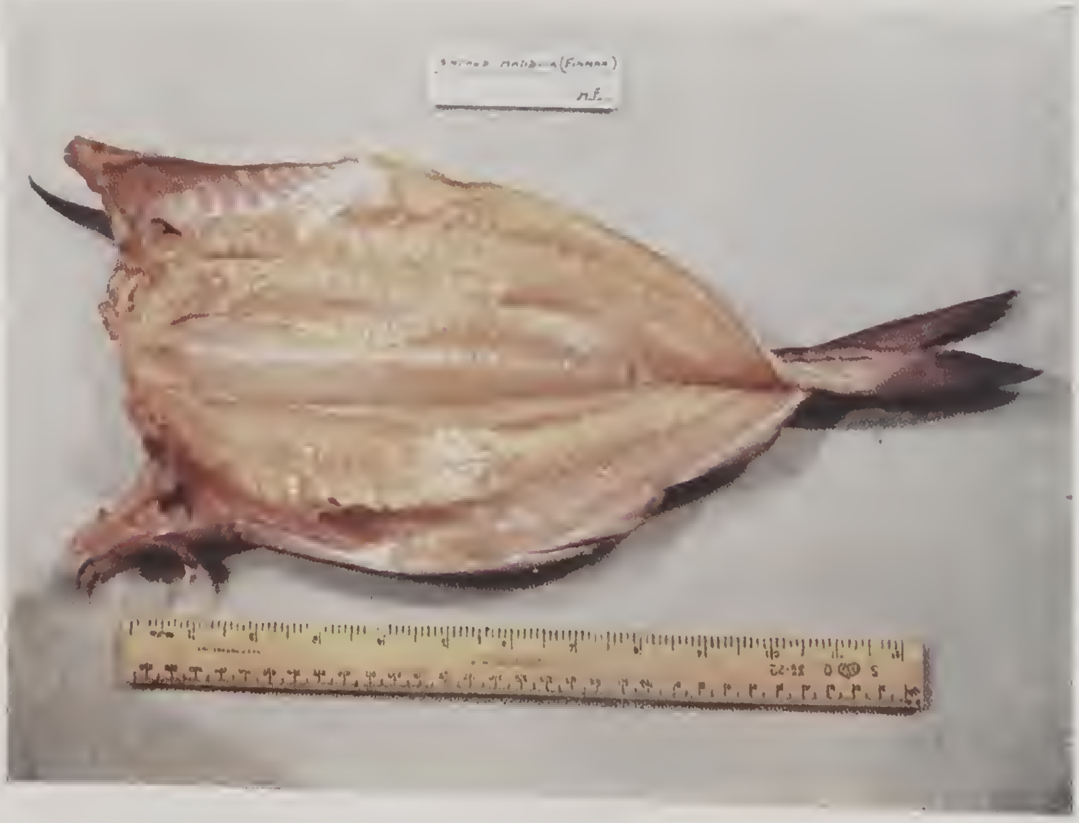
(b)



ter of the nineteenth century to something like the 'finnan haddock' as we know it to-day.

In the eighteen-twenties, the fisherwives of the Scottish north-east coast line fishing villages between Aberdeen and Stonehaven started packing small quantities of home-cured haddocks (called 'Finnons' or Finnans', it is said after the village of Findon) into a basket which they gave to the guard of the *Defiance* stage coach which ran between Aberdeen and Edinburgh.[7] He had a brother in the fish trade in Edinburgh and the business grew. The North Sea haddock was of a size suitable for this type of cure, and it was, as it still is, Scotland's principal white fish.

At Gourdon, near Inverbervie, between Aberdeen and Montrose, a writer in the *New Statistical Account* in 1837[8] says of the haddock fishing, 'till lately, the consumption was chiefly home consumption. In the past year a few individuals have formed themselves into a company for haddock curing . . . and have been carrying on a very successful trade in dressing, smoking and barrelling the haddocks for distant markets, such as London and Glasgow, where they have found a great demand and a ready sale for them.' They went to Glasgow and Edinburgh by sea and coach and to London by steamer. As the trade developed, suitable peat mosses in the vicinity of the fishing villages were soon exhausted, and specially built smoke houses using wood dust were at that time already fast replacing peat smoking in chimneys.

The 'Bervie' cure, as it was called, consisted of split, brined fish, heavily smoked with 'stickly' peat and partly decayed *Sphagnum* moss from the moors, which flamed up and cooked the fish by the end of the process. The product was a dirty blackish-brown and had a flavour between that of a 'Finnan'and a spelding (*see* pp. 168 and 282). The yield from whole fish was only about 42.5 per cent, which means that they must have been quite dry, and kept very well even in hot weather. The 'Bervie' cure, wrote a fish curer in 1882, 'fell into disuse as transit improved', and the Scottish haddock cures which superseded it in the second half of the nineteenth century were 'the direct outcome of the improved transport services of the country.'

Even before the railway reached the Moray Firth, attempts were being made on that coast, too, to supply a more sophisticated smoked haddock to the south. It is obvious, however, from the description of the process given in 1849[5] that the product must still have been very salty, dry, tough and smoky compared with the products we know to-day. After gutting, cleaning, and splitting, the fish were allowed to remain for three to four hours in pickle, which if strong would make the product much too salty for our present tastes. For London and other markets in the south of England the fish was then smoked for as long as eight days in the summer, although only for three days later in the season, when presumably the weather was cooler. Apparently attempts were already being made to speed up and improve the process. At Portmahommack, 'a principal haddock-smoking station of Mr. Hogarth, a process has been discovered, connected with steam, by that firm, which enables the time for smoking to be shortened, and which will give the advantage of a speedier export to market, most desirable in an article of food suited only to immediate consumption', compared with the traditional smoked products which were intended to last for months. All along the Moray Firth, there was similar activity at the fishing villages. At Portknockie there were four smoking-houses; at Findochty three; 'Porteasy' (Portessie) two, and Buckie eight. The price was 11*s.* 6*d.* for 154 fish, less than 1*d.* each, and smoke-curing was becoming a 'rising branch' of the industry.

There were by 1882 three main cures, 'Eyemouths', 'Finnans', and 'Moray Firths' which presented certain differences.

The 'Eyemouth' cure was the most widespread, being practised from Eyemouth as far north as Caithness once the railway had penetrated there, and on the west coast of Scotland too. The fish was normally headed and split so that the bone was on the right-hand side of the fish on looking at the cut surface with the tail downwards. It was brined for fifteen to thirty minutes and then smoked with chips, billets, and hard wood dust for half an hour to two hours, so that the fish acquired a scarcely perceptible tinge of colour and taste of smoke. The yield was about 55 per cent and the keeping 'life' relatively short, four to five days in winter and two to three days in summer.

The 'Finnan' or 'Aberdeen' cure was in Scotland in 1882 still made only along the twelve mile strip of coast between Stonehaven and Aberdeen. The fish was opened down the left side of the ventral fin and split characteristically so as to give a double cut each side of the bone (*see* Plate 29(*b*)). This ensured drying, impregnation with smoke and therefore good preservation in the thickest part of the fish where it was most likely to turn sour on keeping. It was dry-salted over-night, in those days, washed next day, and hung by one 'lug' only on the tenter before smoking, and allowed to drip ('dreep') and dry a little in a kiln, still shaped similarly to the domestic chimney, or 'lum'. Fish had to be shifted 'not under four times' during smoking to counteract the capricious movement of the smoke by natural convection, and 'not under a dozen times' if the draught were bad. The soft grey peat was used, not the black 'stickly' variety, which gave too much heat. Sometimes the position on the sticks of every fish in the kiln, often 2,000 in number, had to be altered three or even more times in the course of one smoking, which normally took between six and nine hours. After cooling and tying in bunches of three fish, they were washed in slightly warm and salted water to remove ashes and dust from the kiln. The surface was hard and glossy as if varnished, the yield 50 per cent, representing a loss of about 10 per cent over that of the 'Eyemouths'. They kept in good condition for fourteen days in winter and four in summer. Fish cured in this way were 'also indebted for their development to the increased transit facilities' and must have been quite different from the 'findrums' of similar name a century earlier, which were most likely more like the 'Bervies' or 'speldings'.

'Moray Firths' or 'Buckie' cure were cut in the same manner as 'Eyemouths' but were smoked more to the extent of 'Finnans'. They were left in the kiln for not under twelve hours and came out well dried and of a beautiful light, golden-yellow colour, not unlike 'Aberdeens'. The yield was also about 50 per cent. To get a uniform product they had to be 'stripped' during the smoking process, as they were finished, and the underdone fish brought down closer to the fires.

Although 'Moray Firths' and 'Eyemouths' are still talked about in Scotland, the two principal categories surviving, pre-1939, were 'Finnans' and 'pales', which were split after the fashion described for the other two cures, and were smoked and dried less than the 'Finnans', so that they were paler in colour. A descendant of the Eyemouth cure is the 'Glasgow pale', which is still smoked so slightly that it has practically no colour and the barest detectable smoky flavour, but keeps well enough when made from fresh fish and transported the relatively short journey from, say, Aberdeen to Glasgow for sale the morning after landing.

The Auchmithie Lucken, or 'close fish' cure, also known as 'Pinwiddies', were haddocks gutted, headed, and cleaned, but not split (hence the name 'close fish'), tied in pairs by the tails, dry salted or pickled for an hour and then smoked in a chamber with draughts excluded for forty to fifty minutes, the fish being cooked in the 'hot-smoking' process. Auchmithie is on the coast of Angus (Forfarshire) between Montrose and Arbroath. An old barrel or a hogshead cut in two would be quite commonly used as a kiln with an old kettle filled with sawdust to produce the smoke and a piece of canvas over the top to keep it in. The fish emerged anything from a dirty brown to almost black in colour on the skin, but the flesh inside was sweet and quite white. The yield was about 42.5 per cent and the keeping quality about a week in summer, longer in winter, the growth of moulds being the deciding factor. This type of product still has to-day a relatively restricted market, chiefly in Scotland, where it is now usually known as the 'Arbroath Smokie' (*see* Plate 28).

The spelding (*see* p. 168) as made at Collieston, twelve miles north from Aberdeen, was typical of the staple cure still made in 1882 from haddocks and kindred fish in those parts of Scotland as yet beyond the reach of the railway service, e.g. the more inaccessible parts of northern and western Scotland, the Orkney and Shetland Islands and the Hebrides. It was gutted and cleaned but not headed, the head being split with the body and left on. After an hour in strong brine the fish were spread out on pebbles to dry for a day, being turned over once and then gathered in at night and pressed down in a heap with stones and other weights for the next two days to ensure a 'nice flat set' (as well as equilibrating, or homogenizing, water content throughout the fish, of course). On the fourth day if dry ('drouthy') they were spread and turned frequently and 'binged' (i.e. piled in a heap, 'bing' having the same meaning as 'ben', or 'hill') before sundown. Temporary waterproof covers were erected to protect from the rain. After a week the fish were allowed to remain in 'bing' a few days at a time to 'sweat out' the salt (meaning pre-

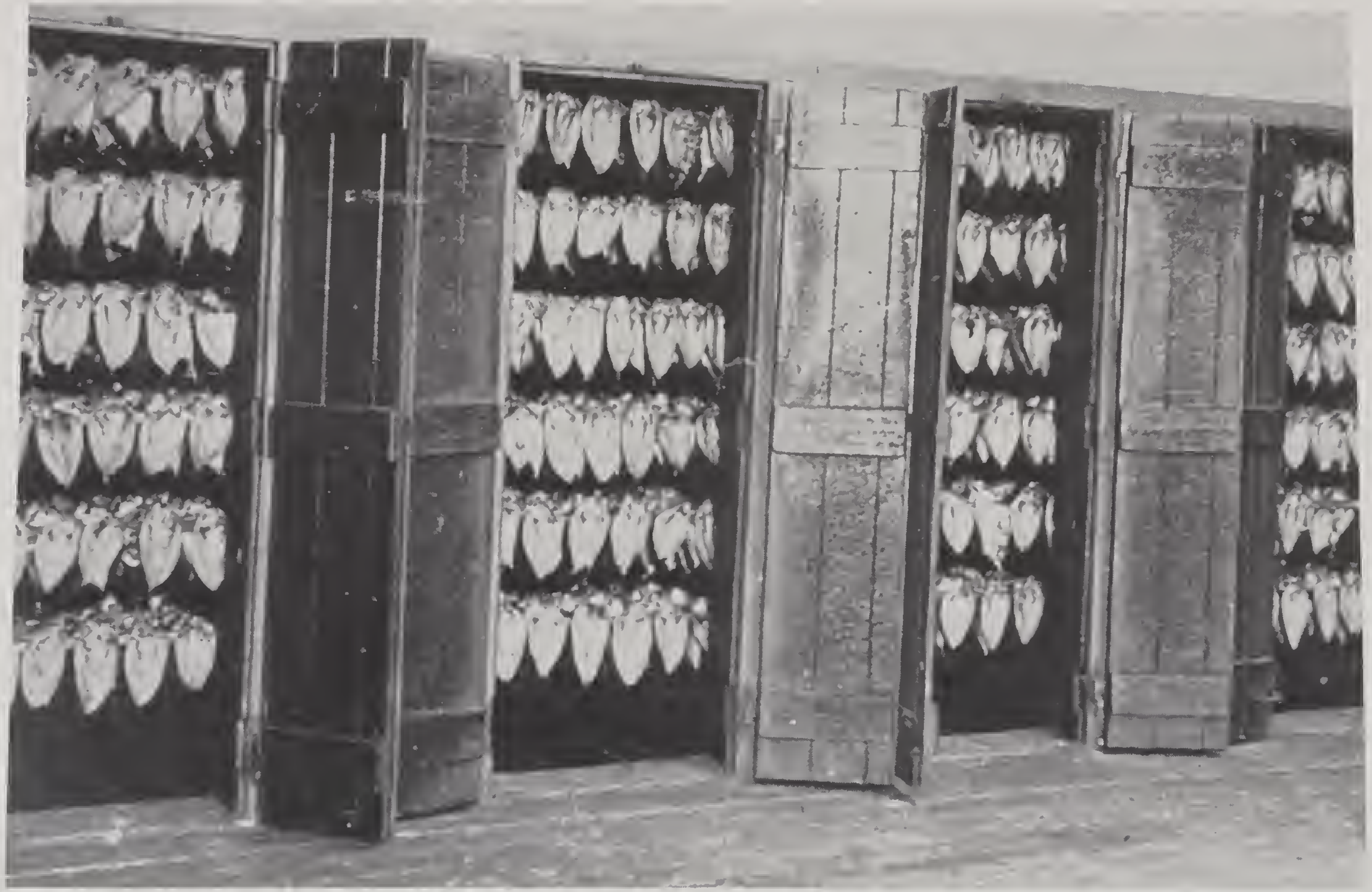


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Plate 30.—Kippers hanging up in smoking kilns.

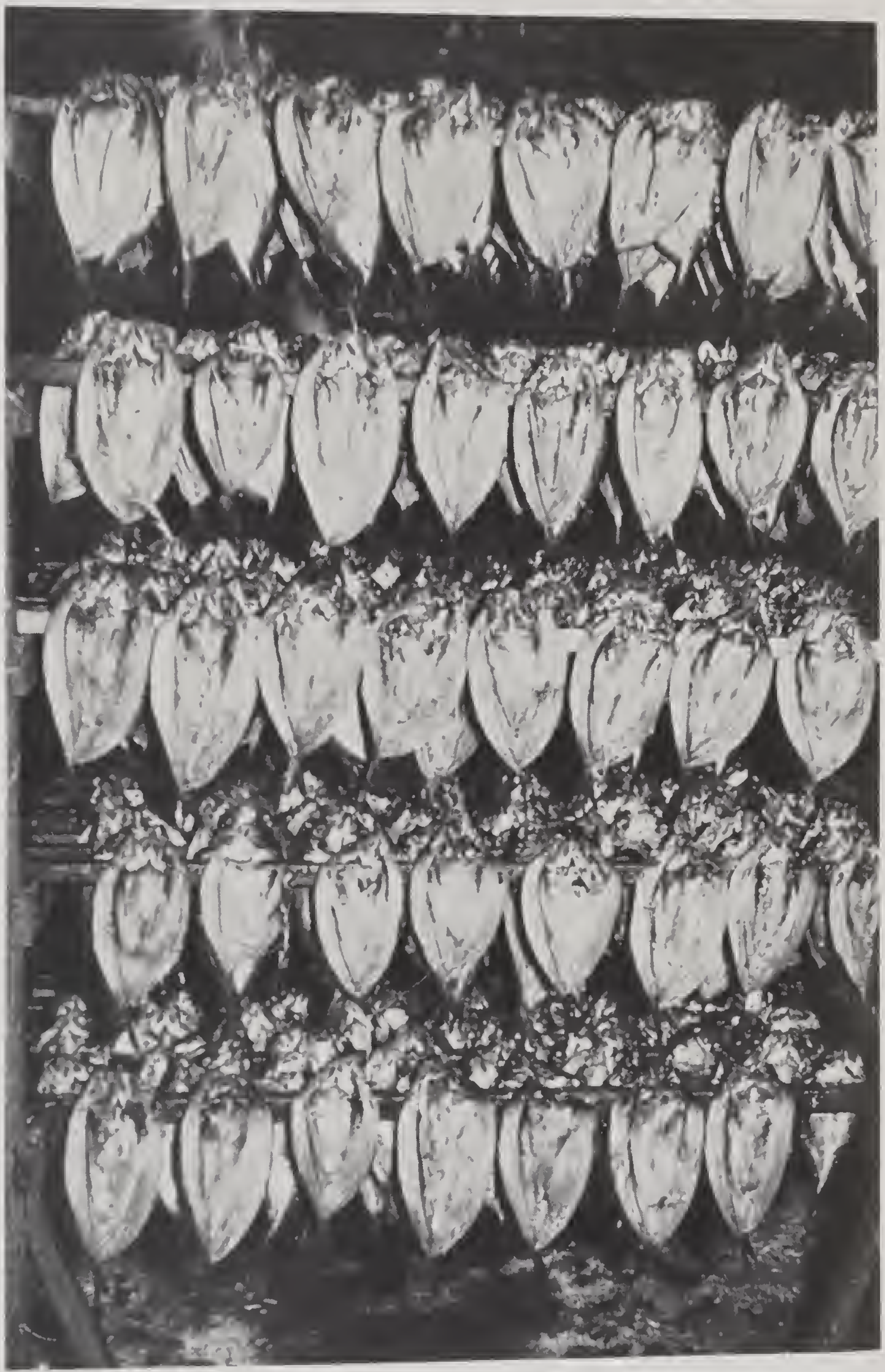

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PLATE 31.—Kippers on tenter sticks in smoking kiln.

sumably to equilibrate under pressure) and make them a greenish-red colour, which was apparently the sign of well-cured speldings (cf. p. 146). Some were then smoked, as in the case of the 'Boddam' cure referred to earlier (*see* p. 168). Such a product might well have stood up to the journey on foot from Buchan to Leith Races (*see* p.168).

The 'speldings' made at Collieston to this day for home consumption, or quick distribution, are much less dried, for a matter of hours rather than days, and do not see the smoke at all.

The smoke curing of haddocks in the Scottish fashion was then introduced into Hull, more or less contemporaneously with the kipper. The first curing house in Hull was opened by Self of Yarmouth, in 1847. At that time comparatively few of the trawled haddocks caught reached the market. Even later when ice was available, too many could not be carried fresh for fear of swamping the market. Smoking therefore provided a new outlet. London also took up smoke curing at about the same time, presumably using haddocks caught by the early Barking trawling smacks. The first smoke house was erected at Grimsby a little later, in 1856, but by 1877 there were forty-one such premises employing about 400 people out of a total industry of 5,100, of whom 3,470 were crews of smacks.[10] The price of haddocks rose as a result of this demand and the importation from Scotland diminished.

There were complaints from the small fishing villages of north-east Scotland that mass production was leading to a lowering of standards. In 1883, Mr. John Ross, jun., of Muchalls, near Stonehaven—the firm is now established in Aberdeen—who was the 'Winner of the First Prize Silver Medal at the Edinburgh Fisheries Exhibition, 1882, for Real Peat-smoked Aberdeen Finnan Haddies', detailed his own laborious technique, already described, in answer to the 'everyday' question, as he puts it, 'Why are Real Aberdeen Finnan Haddies, of good quality, so difficult to be obtained; and when got, why are they so much higher priced than haddocks cured in any of the other styles, such as Eyemouths or English-cured?'[11] At that time, just before the introduction of steam trawling, there were only 'a few Real Finnans made in Aberdeen itself [and] the practice [was] of very recent introduction, and still confined to three or four individuals.' The great bulk made were still 'the handiwork of the fishermen's womenfolk, each curing their own share of the catch' of inshore fish, still not gutted at sea, 'and within the past twelve to sixteen years, the cure in their hands [had] much deteriorated . . . solely through carelessness in handling and the use of . . . hard, stickly peats instead of soft, grey ones, and an indiscriminate use of sawdust . . . The fisherwomen's sole aim [seemed] to be getting colour quickly on the fish; and to do so with little trouble to themselves, they select the most resinous sawdust they can, thus certainly gaining time, but at the expense of flavour, which is . . . bitter and disagreeable, causing great uneasiness to eaters at all bilious.'

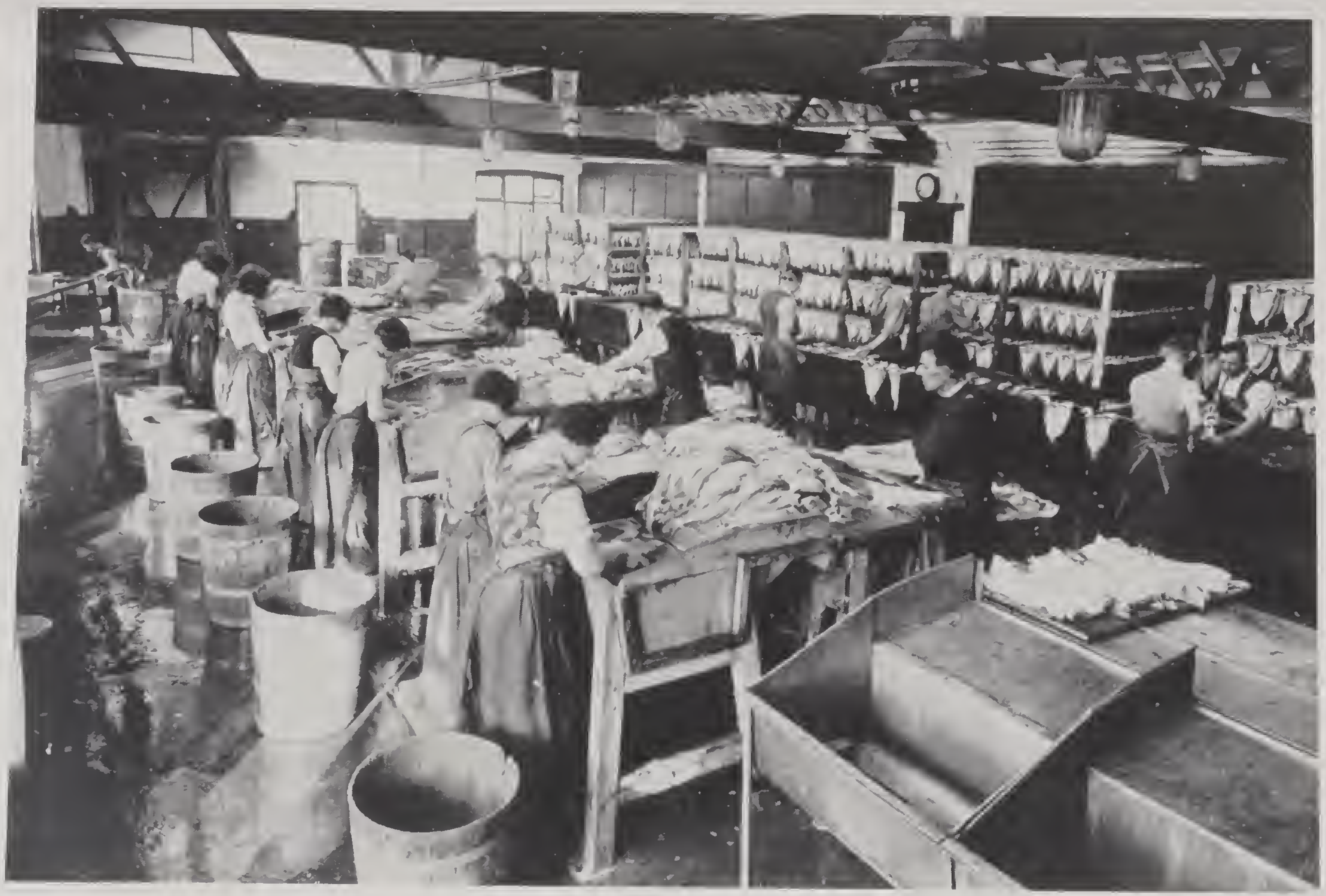
The establishment of steam trawling immediately after this led to a further concentration of the industry at the larger ports, such as Aberdeen, which soon relied almost entirely on sawdust (itself a by-product of the local boxmaking industry, ancillary to trawling), although a proportion of peat is still sometimes used to confer a specially delicate flavour.

In 1907 there were seventy fish-curing establishments in Aberdeen, producing both 'Finnans' and kippers. Grimsby firms have developed a high reputation for their 'Finnans', produced on a considerable scale (*see* Plates 32 and 33). Hull, on the other hand, makes more kippers. In spite of this tendency towards centralization of curing at the larger ports, in most fishing villages, particularly on the Scottish coast, may still be seen small smoke houses of brick or wood perhaps four feet square and six or seven feet high with bars for supporting several dozen tenter sticks full of fish. In these the fishermen and their wives still smoke to perfection their haddocks and herrings when they can be caught.

BUCKLING

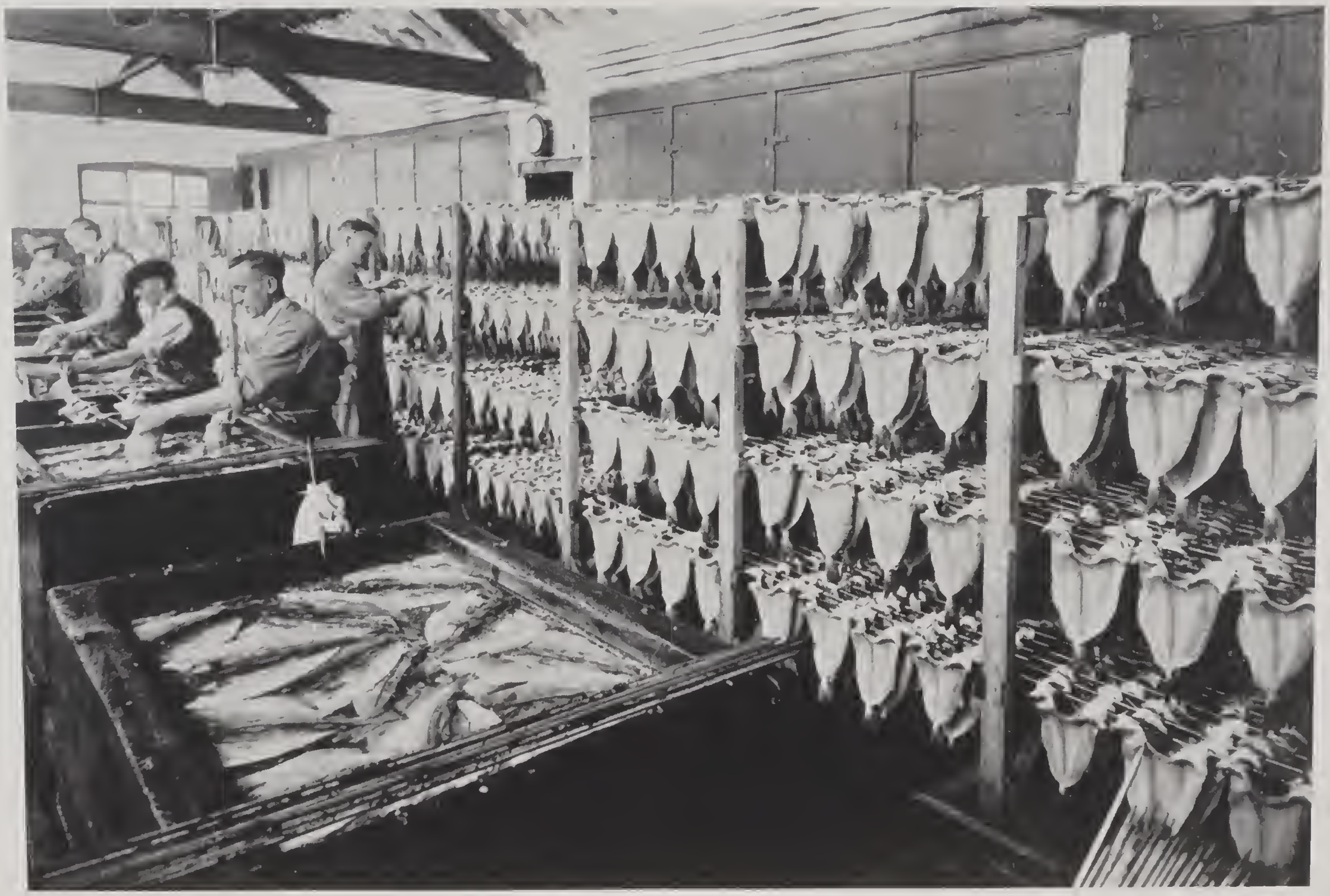
With the exception of the 'smokie', all the smoked fish products hitherto described are 'cold-smoked', the temperature of the smoke not normally exceeding about 85° F. (29.5° C.). On the Continent, the 'hot-smoked' products such as *Bücklinge* (*anglice*, 'buckling'—*see* Plate 28) made from herring, and mackerel, salmon, sturgeon and eels, are more characteristic although, since they are cooked, they are probably, if anything, even more easily perishable commodities.

There are two main processes used on the Continent to-day for the preparation of buckling, the traditional process, as prac-



By courtesy of Ernest Cox, Grimsby.

PLATE 32.—Splitting and cleaning haddocks for 'Finnans' at Grimsby.



By courtesy of Ernest Cox, Grimsby.

PLATE 33.—Brining and hanging haddocks on speats before smoking as 'Finnans' at Grimsby.

tised characteristically on the Danish island of Bornholm in the Baltic, and the German 'smoke ovens'.[12] It is tempting to suggest that the Bornholm process may be the descendant of some much earlier process, perhaps in existence at the time of the Scania fishery, when it is known that a good deal of fish was smoked although it is believed, perhaps for want of evidence, that the product must have been cold-smoked similarly to the red herring. The '*Strohbücklinge*' was '*hart geräucherte Bücklinge in Körben mit Stroh verpackt*' (i.e. hard-smoked buckling packed in baskets with straw), and the equally hard smoked '*Kappeler Bückling*' (from Kappeln near Kiel on the Baltic), kept for two or three weeks.[13] It is clear that what we know now as buckling must be a much more highly sophisticated product, since in earlier days such a perishable commodity could most certainly not have been merchanted without spoilage during distribution. Like the kipper and Finnan haddock, the present-day buckling is a product of the age of steam locomotion, although, like the 'Finnan', it may well derive from some localized product, prepared on a domestic scale.

In the Bornholm process to-day, the herrings are mostly eviscerated before smoking, resulting in a 30 per cent average loss of weight. They are salted either before smoking by immersion for about half an hour in 10 to 12 per cent salt solution (which corresponds to only about 40 per cent saturated brine) or else they are smoked unsalted and then lightly sprinkled with about 3 per cent by weight of salt before packing.

The fish are hung in pairs on wooden sticks, with the head of one fish inserted through the gill cover and mouth of the other. They are then pre-dried in the open air, weather permitting, on wooden frames. If it is raining, they are pre-dried in the smoking kiln, but the temperature is not allowed to exceed 86° to 104° F. (30° to 40° C.). The object of this pre-drying is to make the head and skin tough, so that the fish does not fall down when its flesh is subsequently softened by cooking.

The kilns are constructed of bricks and are about ten feet square at the bottom. The floor of the kiln consists of five bricks raised about twenty inches above floor level. The kiln narrows towards the top like a pyramid with the apex removed. A fire is lit on the floor and during the smoking process this is continuously raked backwards and forwards; this is the central feature of the process. If the fires were left in one position, presumably the heat would be excessive and the fish would either fall off or be scorched.

In more modern premises, the fire is now placed on a flat trolley, which is pushed backwards and forwards. The sticks of fish are only about two feet above the floor of the kiln, which holds about four hundredweights, that is, about an English cran, of fresh fish. The smoke treatment consists of two successive phases, distinguished by an increase in temperature. When it is considered that the fish have been sufficiently toughened by drying to stand the extra heat required for cooking without falling off the sticks, the outlet from the kiln is closed by means of wooden dampers and the second part of the process commenced.

The fires usually consist of one layer of logs and the dampers are just above the fires. Alder wood is preferred; coniferous woods result in a bitter flavour. The fires are sprinkled with water if there is too much flaming. If the fish is being pre-dried in the kiln instead of in the open air, smoking proper is not commenced for about half an hour. Smoking is continued until the fish have a golden colour, and the desired smoky flavour and cooked consistency. The temperature of the smoke in the second phase is about 140° F. (60° C.) at the beginning, rising to 194° F. (90° C.) at the end.

Throughout this phase the fires are kept damp by means of a swab soaked in water in order to maintain humid conditions and to prevent excessive flaming, which would result in too high a temperature and too little smoke. This process usually takes one and a half to two hours.

Finally, the dampers are opened so that the fires burn up more freely, the temperature rising from about 176° to 212° F. (80° to 100° C.) for a short period, which has the effect of drying the fish on the outside. The fires are then extinguished and the fish taken out of the kiln to cool. The over-all yield is about 55 to 60 per cent of the fresh weight.

Outside Bornholm, the commonest type of kiln is some variation or other of the German 'smoke-oven'. Such small production as there is of buckling in Britain is carried out in versions of this apparatus. The most typical kilns are usually constructed of brick and are about six and a half feet high and about a yard square in section. The lower part and the floor are built of firebrick. There is an iron door in the front of the kiln opening in three parts, the bottom part for tending the fires, the middle one for hanging the fish and the top one for controlling the draught. The kiln is connected to a chimney by means of a short duct about ten inches square. Each kiln in a battery would have an independent outlet to the chimney into which it is carried obliquely, with a damper to regulate the draught. About two and a half feet up there are angle irons along the sides about ten inches apart, which hold wooden smoking frames carrying the 'speats', or 'spits', on which the fish are threaded through the eyes or the mouth and gills. Each kiln holds two or three frames. The process is broadly similar to the Bornholm procedure.

Pre-drying is carried out at an air temperature of about 86° F. (30° C.) with the doors half open and a damper open. The frames are turned round once or twice during the smoking process, and the top and bottom frames are interchanged so as to provide uniformity of treatment. After three-quarters of an hour the temperature is raised and the fish cooked over a bright fire. Lastly, the fish are subjected to a dense smoke for about an hour, with the damper partly closed and the fires damped down with sawdust and water. The temperature of the smoke reaches 212° to 248° F. (100° to 120° C.)

The fish are normally packed for transport and distribution into 3 to 5 kg. (6½ to 11 lb.) boxes with an inside liner of parchment paper. If not previously brined, they are now sprinkled with coarse salt, 5 kg. of fish receiving 150 g. (5 oz.). This treatment tends to confer a slightly shiny appearance on the surface. The fish are dispatched and sold upside down, which is supposed to result in a better appearance.

The product contains on the average about 12 per cent of fat and 2 to 3 per cent of salt, and it only keeps fresh for four to five days at atmospheric temperatures of 64° to 68° F. (18° to 20° C.) after which mould begins to develop on the skin.

DYE

There seems little doubt that as the standard of living rises, palates get increasingly sophisticated and, as a result, the smoked products evolved last century are themselves being subjected to a process of evolution in the direction of ever milder and softer cures, tending ultimately perhaps to the delicate and delectable but fugitive flavour of the 'Glasgow pale'. The traditional brown or yellow appearance, however, is now largely maintained by the use of artificial colouring matter.

The United States, which took up mild smoke curing soon after Britain (e.g. Boston first made 'Yarmouth bloaters' in 1859), seem to have been the pioneers in this form of adornment or, as some might say, deception. Already in 1884 it was complained in an official publication that 'there are manufacturers who injure the smoking business by manufacturing smoked herring which have not been near smoke by curing the herring with a specially prepared yellowish brown varnish or oil which imparts to the herring a little of a smoky flavour.'[14] Presumably, this additive was a species of smoke essence, perhaps even pyroligneous acid produced by the destructive distillation of wood and now practically universally prohibited owing to health hazards. It was then but a short step to the addition of dyestuffs pure and simple, and the use of saffron for artificially colouring finnan haddocks was reported in 1890.[15]

Perhaps partly because of the early enterprise shown by 'food colorists' in the United States, the institution there of the 'Pure Food Laws' has led to the complete cessation of the practice of fish dyeing in most of the States of the Union and a virtual prohibition of dye in imported smoked fish on account of the ban operating in key States through which imports have to pass.

In Britain, on the other hand, where there is no such absolute ban, certain synthetic dyes, generally accepted as harmless, were widely adopted between the wars for 'improving' the appearance of kippers and of smoked fillets which would otherwise either look unduly pale or be excessively dry. However, since 1939, its use has spread to 'Finnans' where it is less defensible although presumably the familiar arguments will in time be used to justify it. Annatto, a vegetable dye, has also been used for white fish, but the dyes mostly used for smoked fish in Britain to-day are obtained by blending standard dyestuffs, such as Tartrazine, Amaranth, and Orange I, together with a brown dye in the case of kippers, to give mixtures known by various trade names, such as 'Lemon', 'Amber', 'Golden Brown', and 'Kipper Brown'.

As a result of the decreased smoking and drying which dyed fish normally undergo, compared with an attractively, naturally coloured product, smoked fish no longer keeps as well as it used to in the 'good old days'.[16] Some people counter this statement by pointing out that last century's commodity must have been so tough and tarry that there is no wonder that it kept so well, and that there is no need to-day for an inordinately long 'life' in any case, provided that it is eaten immediately after purchase.

Now it is quite true that, as previous chapters have shown, there is an historical trend towards ever less tough, dry and salty fish products, and there is no reason to suppose that in this, any more than in other spheres, evolution has yet come to an end. In the United States, even more than in Britain, there is a tendency to produce a mildly smoked, pleasantly flavoured product, which has lost very little weight or tenderness by drying. Attempts have even been made, but not followed up, to accentuate natural colour by increasing alkalinity during smoking, either by incorporating sodium bicarbonate in the preliminary brine dip, or by leading ammonia vapour into the smoke. However, the keeping quality of this mildly smoked type of product is often little if any better than that of unsmoked fish, and it needs to be kept in refrigerators at about 32° F. (0° C.) during distribution.

In Britain to-day, on the other hand, the chilling of smoked fish throughout the distribution chain is by no means accepted established practice, although rail vans from Aberdeen to London in summer are sometimes subjected to some cooling with solid carbon dioxide.

A further factor militating against the satisfactory keeping quality of a good proportion of Britain's smoked fish at the present time, is the delay between catching and smoking. In the case of white fish, the product at landing, as shown in Chapter 10, is, if caught early on in the trip, often indifferent. During the period 1939–45, the pernicious practice even arose of labelling 'For Smoking Only' fish that was too suspect to distribute unaided, through the fresh fish channels. In defence, it must be realized that, but for this practice, thousands of tons of fish might have been lost, and Britain been that much less nourished. Even herrings are not now always as fresh as they used to be before kippering. Fish landed, perhaps at out-of-the-way ports, are often sent overland long distances to be kippered even in summer, without adequate icing, sometimes merely 'roused' with a sprinkling of salt. In addition, in order to retain labour and keep factories in use throughout the year, fish outside the main seasons, by no means always plump or fatty, are nevertheless extensively kippered.

As a result partly perhaps of the mediocre quality of some of the products in competition with a greater supply of alternative food-stuffs, the British consumption of smoked fish, although still probably greater than anywhere else in the world, has recently been showing a tendency to fall. In 1952 it stood at about 12,000 tons of finnans, 18,000 tons of fillets, 35,000 tons of kippers and 1,500 tons of bloaters.

Along with the growth of filleting at the ports, the proportion of white fish smoked as fillets has increased. Hull and Grimsby, relying mostly on distant-water cod, make single fillets, two from each fish. Aberdeen, with large numbers of small North Sea haddock, has since 1918 developed a 'golden cutlet', which consists of a double fillet, with the flesh, or the majority of it, removed from the fish all in one piece, the dorsal fins in the middle.

In the case of the kipper, too, bones are best absent and a small market has been built up for kipper fillets, or kipper 'snacks', as one firm called them, smoked in the usual way after filleting so as to cut away the belly walls, and brining for a short time. In fact, George Peter of New Jersey took out a patent in 1878 for skinned, boned, smoked herrings, tied together in bunches. The name 'Edinburgers' has recently been coined by the U.K. Herring Industry Board, whose headquarters are in Edinburgh, for a product of this type, cooked and frozen for export as a luxury pack to the United States.

Smoked salmon, when mildly treated (*see* Plate 34), has also become quite a different commodity from the hard, salty product still customary in Norway for long-term preservation (*see* p. 85). Mildly cured by lying for a day or so in salt, occasionally fortified with saltpetre, demerara sugar, rum, etc., and smoked in an ordinary kiln often with a proportion of juniper wood as fuel, the product although delightful when sliced and eaten raw, can be kept for only a week or so at most in summer.[17]

An 'ersatz' smoked salmon is made in Germany from saithe,

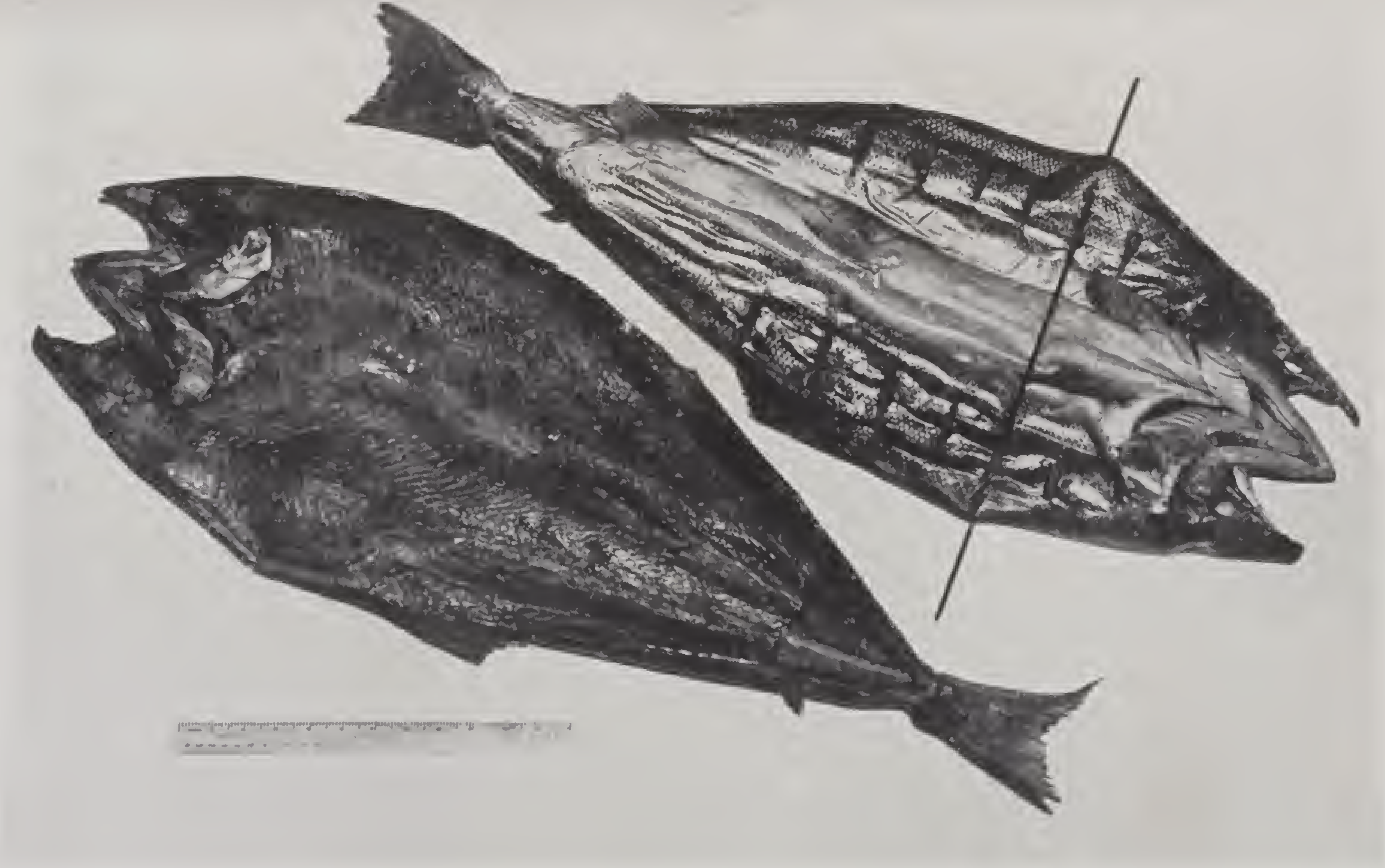


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PLATE 34.—Mild cured, kippered salmon (now mostly smoked as fillets).

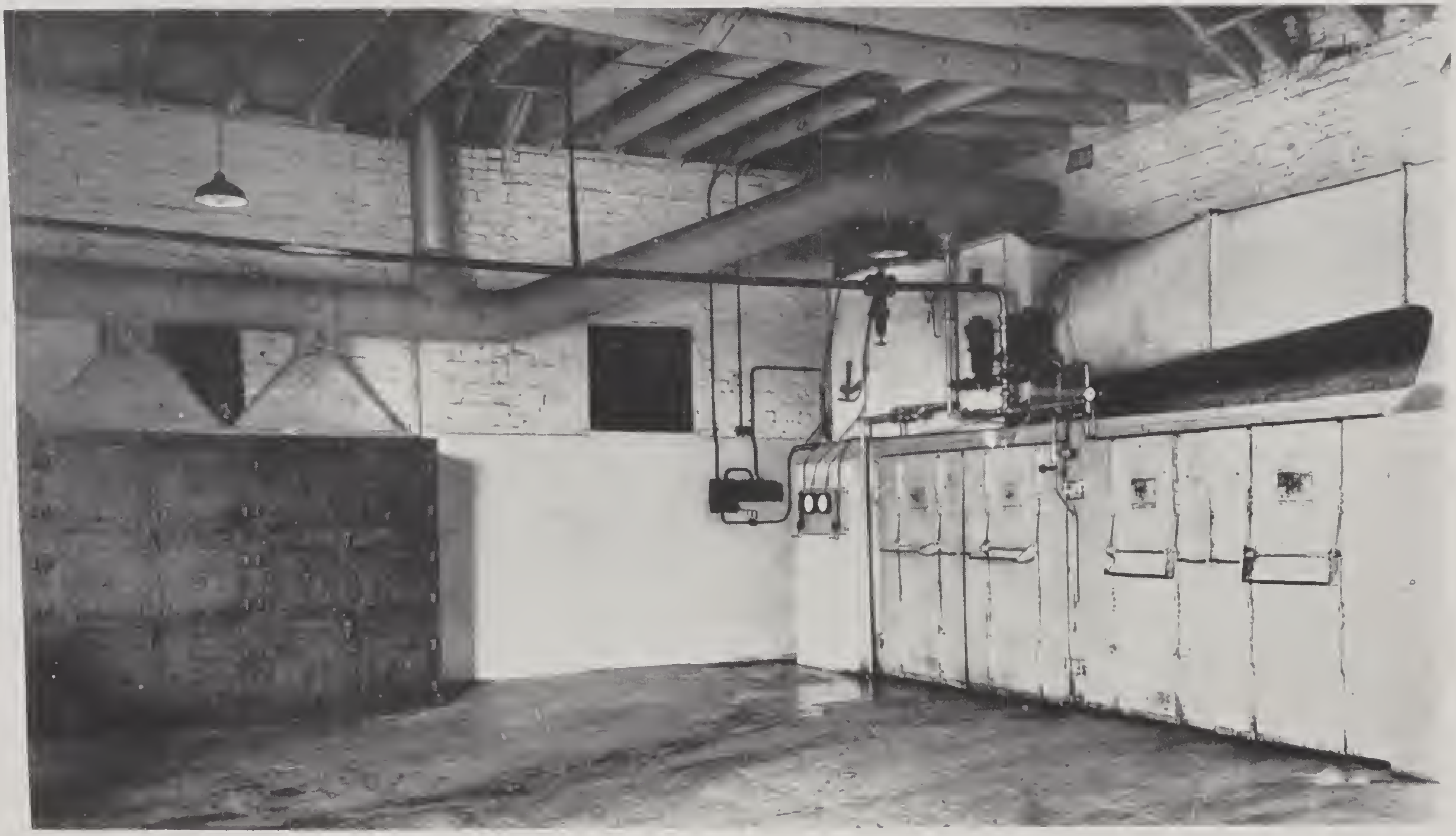

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PLATE 35.—Modern mechanical fish-smoking kiln (Newhaven).

otherwise known as coal-fish, the German word for which is *Seelachs* (i.e. literally, 'sea-salmon', *see* p. 171).[18] This is first filleted and salted for a week or more, and then cut and sliced into pieces of about one-sixteenth of an inch in thickness. These are dipped into a red dye, of coal tar origin, then either smoked for about twenty minutes or else immersed in a solution of 'smoke essence', produced by wood distillation, and finally packed in tins with oil and sealed without sterilization.

RECENT TRENDS AND DEVELOPMENTS

It will be seen from the foregoing descriptions that although the smoked fish products have changed substantially in response to the industrial era, nevertheless, as far as cold-smoking is concerned, the methods employed for smoking by suspending the fish above smouldering fires have not changed in any major sense since the 'black houses' mentioned more than 600 years ago.

For a number of reasons the traditional kilns are unsatisfactory for the manufacture of the products of to-day, which demand greater care than the dark, salty, 'high-dried' products of the past. Already, in 1882, fans or 'Roots' blowers' were said by one writer to be used 'in all large curing establishments' to facilitate drying.[9] If this were true, then they must have dropped out of use, probably because their effectiveness was too marginal. However, there has been a constant succession of attempts to devise improved, mechanical kilns, and a number of fairly successful models are being adopted on an increasing scale, particularly in Britain (*see* Plate 35),[19] Canada,[20,21] and the United States,[22] as well as in Norway[23] and Germany,[18] for hot smoking.

Moreover, the mechanical splitting and filleting of herring prior to smoking is now well established. Filleting machines for white fish, which are much more variable in size than herring, are still being developed, and the splitting of white fish for subsequent smoking, which requires considerable care, is still done entirely by hand. Fish smoking has been developed to more of an art in Britain than in most countries—Norway, for example—many of which can and probably will learn much from British experience and methods.

In tropical climates the white populations, particularly those of British origin with a liking for mildly smoked fish, already import appreciable *per capita* amounts of smoked fish, chiefly from Britain. Usually the temperature and humidity conditions in such climates are so high as to preclude the local manufacture of cold smoked products, although an experimental air-conditioned smoking kiln, using the heat pump principle, has been described for use in the warm climate of Queensland, Australia.[24] However, the keeping quality of mildly smoked fish would also be very short in tropical climates, unless chilled by mechanical refrigeration, when it would normally keep in edible condition for a week or two at 32° F. (0° C.). Probably proper hard freezing is the best way of ensuring distribution in sound condition. 'Quick freezing' (*see* p. 298) is perhaps not so important with smoked fish as it is in the case of fresh fish, and 'sharp freezing' has proved satisfactory. This is perhaps because textural changes and drip resulting from slower freezing are not so noticeable in the case of a product which has already been toughened and partially dried in the smoking process as in the case of fresh fish.

The presence of 2 or 3 per cent of salt in smoked fish depresses the point where it begins to freeze a few degrees below that of fresh fish. Much of the smoked fish that has been exported from Britain in the last twenty years to South Africa and Australia, the chief importing countries, has been stored at temperatures on the ship of about 10° to 15° F. (−12.5° to −9.5° C.) at which rancidity in the case of fatty fish, such as kippers, is noticeable within a few weeks. The condition of this fish by the time it was consumed must have left much to be desired. Generally speaking, thawing and smoking cold-stored whole fish yields a somewhat better product than freezing and cold-storing the smoked fish. As pointed out in Chapter 12, only very much lower storage temperatures in the range −10° to −20° F. (−23° to −29° C.) can preserve frozen fish in first-class condition for several months, and the facilities for this really low temperature storage are being steadily extended.

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Chapter 12

FREEZING OF FISH

Introduction

Chilling by contact with melting ice at 32° F. (0° C.) lowers the temperature of fish to about this value, but cannot result in actual freezing. The presence of small amounts of dissolved salts, etc. in the tissue fluids depresses to about 30° F. (−1° C.) the point at which the water in fish flesh begins to solidify into ice.

For long it has been realized that hard freezing is a potent method of preservation, although the principal reason, namely, the further inhibition of microbial multiplication at sub-freezing temperatures, was not understood until after the work of Louis Pasteur (*see* p. 9). Freezing, successfully carried out, has the special advantage, common to none of the other methods of preservation previously described, of permitting the presentation of the fish, as it were, in the fresh state, to be consumed as such or after processing at will.

Preservation of fish by natural freezing had long been practised in cold climates before the development in the last quarter of the nineteenth century of methods of artificial refrigeration based on the successive compression, cooling, and subsequent expansion of easily condensable gases, such as ammonia. The technical aspects of subsequent developments are part of the history of engineering, and detailed discussion is beyond the scope of the present work, which is devoted to a single commodity. However, it may be pointed out that there is a causal relationship of action and reaction between, on the one hand our expanding knowledge of the basic requirements of a process for keeping fish in good condition by freezing, which are determined by the fundamental biochemical and biophysical properties of fish, and on the other hand the development by engineers of the technical means by which this can be done.

NATURAL FREEZING

Frozen fish was early on a commonplace commodity in countries with cold climates, such as Russia and Canada. In

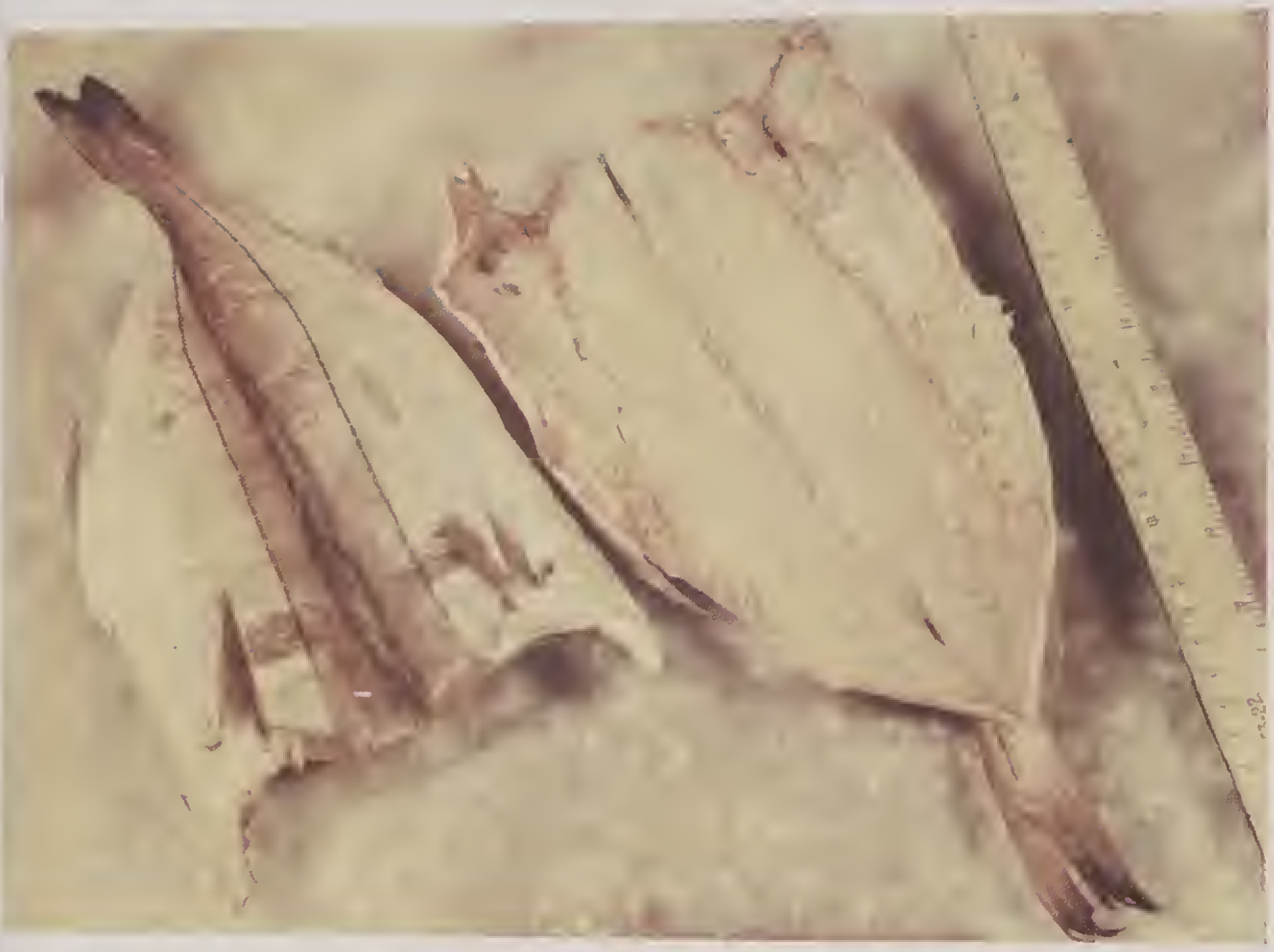

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PLATE 36.—Badly cold-stored fish. Very fresh haddocks, rapidly frozen, *but stored at 14° F. (– 10° C.) for five months*, then thawed, split and smoked in mechanical kiln. Note opacity of flesh and lack of gloss compared with fresh fish (Plate 29 (*b*) and properly cold-stored fish (Plate 37 (*a*)).

Russia, during the winter, even in the nineteenth century, there were shops filled with frozen fish, an axe and saw being used in order to cut them up for customers. Salmon, frozen naturally in barrels, were imported from Canada about the middle of last century by a Scottish fish merchant by the name of John Anderson, with bad results. This was presumably owing to a combination of extremely slow freezing, the development of oxidative rancidity in a fatty fish if stored, as these probably would have been, at a temperature only a little below freezing point for some time, and also perhaps the difficulty that would be encountered in thawing out such a large mass of frozen fish.

The natural freezing of herring as bait for the cod and halibut liners of New England became common practice by the middle of last century. They were frozen in Newfoundland on platforms erected aboard ship or on land, and then packed in straw for transport. The fish were simply exposed on a scaffolding about seven feet above the deck in layers a foot or more thick if it was very cold, but only in very thin layers if the atmospheric temperature was but slightly below freezing point, the fish being turned over by means of a shovel all the time.

Shore freezing, carried out in New Brunswick and Newfoundland, consisted merely of spreading the fish out on a clean, gravelly beach to a depth which varied from a few inches to a foot, depending on the conditions. Herrings frozen in this way were tried out for food with some acceptance, and by 1880 had become, according to an official U.S. Fisheries Commission report, 'a favourite article of food among the labouring classes of the larger cities and are distributed to a considerable extent among the people of the smaller country towns . . . They have a great advantage over the ordinary fresh fish in that they can be packed in barrels and shipped to a considerable distance without danger of loss.'[2] They were carried direct to Boston, New York, and Pennsylvania, and thence to Washington and as far as the Mississippi. On arrival, some fish were thawed out and salted by dealers for sale as pickled herring or else smoked. The product was described as not particularly agreeable, since the fish 'became very soft and their flesh is of a peculiarly dark and unattractive colour'.

In Norway, too, herrings were frozen for bait by the cod fishermen before the introduction of mechanical refrigeration. The herrings were placed in metal containers and frozen in ice-salt mixtures and kept cool on the fishing vessel by the same means.[3] This procedure is still used by British 'steam liners'.

MECHANICAL REFRIGERATION

Apart from the isolated instances just mentioned, freezing has had a shorter history than any of the other processes previously described.

The appearance of artificial refrigeration in the eighteen-sixties, led to various isolated attempts to preserve fish by freezing them, usually with poor results. However, it is claimed by Mr. Anderson Smith that in 1870 he sent five cases of haddock and other fish frozen into a solid mass, to the famous marine naturalist, Frank Buckland, in London, and that a number of experts 'reported most favourably on the process.' Also, it was claimed that a solid mass of fish and ice prepared in this way 'was displayed for a week in summer time in a fishmonger's shop in Glasgow without any deterioration.' Similar attempts seem to have been made in the latter part of last century to preserve herring by freezing. A writer in 1885, expressing a desire to see refrigerator cars made available in this country, points out that although in the United States since 1846 frozen herring had been providing the masses with a cheap and wholesome food, 'the introduction or rather attempts to introduce the frozen herring trade, or of employing other artificial means for preserving fish for a certain period of time in a fresh and wholesome condition, into this country, dates back for only a few years.'[4] He concludes: 'The process has not made any advance and is not popular.'

In the early days of freezing, no particular distinction was drawn between the process of freezing hard and the subsequent storage. Fish was merely put into a cold store at a temperature below its freezing point, allowed to set hard, and left there until required. Numerous people with refrigerators must have tried this out at various times, but their names appear to be mostly unrecorded, probably because of the unpromising nature of the results of such experiments.

It is quite clear from subsequent experience and research that although fish treated in this way might at times have appeared superficially to have a better keeping quality than ordinary, 'fresh' fish, the quality attained must nevertheless have been very poor. In fact it was such crude methods of freezing that initiated prejudice against frozen fish. It began to be realized that special methods of freezing had to be developed if satisfactory frozen fish was to be obtained.

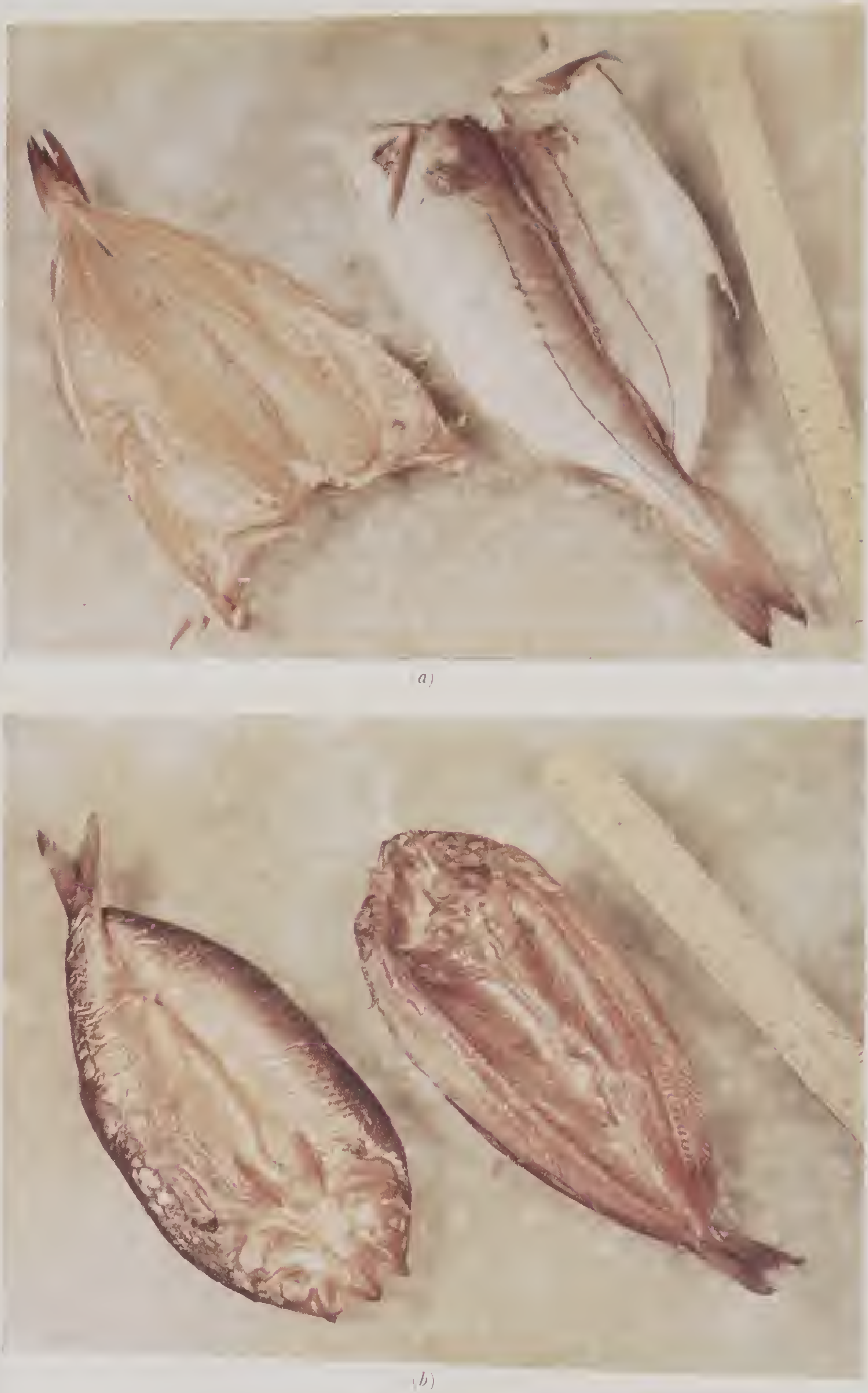
Although fish may appear to be frozen quite hard at, say, 20° to 25° F. (−6.5° to −4° C.), nevertheless the putrefying bacteria are still capable of living and multiplying, although less actively than at 32° F. (0° C.), so that the fish can still go bad in the normal way, only more slowly. In addition, in this temperature range, particularly adverse effects are caused by other changes, such as the toughening action on the tissue of the residual, concentrated fluids in the partially frozen fish, and the drying that occurs during cold storage. Both these effects are reduced by further lowering of storage temperature. At about 15° F. (−9.5° C.) microbial action is completely suspended, so that fish cannot go bad in the accepted sense. However, at this temperature, the storage life of fish in first-class condition is only a few weeks, and after a few months it is practically inedible (*see* Plate 36). The activity of 'enzymes' (i.e. non-living ferments) and oxidation processes which result in rancidity of fats, etc., contribute to loss of palatability and are not completely inhibited even at temperatures as low as −20° F. (−29° C.).

Until comparatively recently, it was commonly thought, even by experts, that frozen fish could be damaged in some way if the temperature to which it was subjected was 'too low', by which was meant, presumably, below the level then easily obtainable commercially of, say, 5° to 15° F. (−15° to −10° C.). It was less than twenty years ago that it began to be shown conclusively that not only were fish not damaged by being reduced in temperature to well below 0° F. (−18° C.), but their storage life was in fact much improved, because as might be expected, all chemical and enzymic reactions were still further slowed down. Moreover, the same applies to physical effects, such as loss of water from the tissues by evaporation and damage to cell structure owing to the coalescence of ice crystals in the frozen fish. As a result, at temperatures of about −20° to −25° F. (−29° to −31° C.), the storage life of most species can be extended to about six months in really first-class condition, i.e. as good as fresh, provided they were perfectly fresh to begin with (*see* Plate 37).[5]

The research of Plank and Reuter on meat in Germany in the early nineteen-tens, led to recognition of the importance of freezing rapidly to conserve tissue structure and thus minimize 'drip' formation during and after thawing, and avoid the deterioration in texture, or 'chewability', of the cooked product resulting from slow freezing.

The most convenient, and comparatively successful, method of 'rapid freezing' at first employed for fish was direct immersion in a refrigerated brine, nearly saturated with common salt. 'Sharp freezing' by merely placing the fish in a cold store, sometimes on refrigerated pipes, or with a slight air circulation induced by a fan, was until recently a common method in land installations and it is still used to some extent. Such a procedure takes twelve to twenty-four hours at the best, much longer if the fish are in boxes, and thus does not result in 'quick-freezing'. This term is by definition of the Ministry of Food now limited in Britain to processes in which no part of the product takes more than two hours to be lowered in temperature from 32° to 23° F. (0° to −5° C.). This range is one in which adverse alteration to the properties of the flesh occurs most rapidly, and it is therefore often referred to as the 'critical zone'. Using cold air this is only possible with a fairly good 'blast' of ten to fifteen feet per second at a temperature of about −20° F. (−29° C.) even in the case of a fish or package only a few inches thick. There are also various methods involving freezing by indirect contact with the cooling medium, as for example by pressing between cooled metal surfaces which is the basis of the 'Birdseye' and 'Jackstone' freezers. The concentration by engineers and others on the devising, manufacture and selling of apparatus for 'quick-freezing' perhaps tended to distract commercial attention from some of the other fundamental requirements of good quality frozen fish, revealed by more recent research, in particular, the need for really fresh fish and for much lower temperatures of storage than were formerly thought necessary or desirable.

In the light of these general principles, the failure of the nineteenth-century experiments in freezing fish can be under-



(*a*)

(*b*)

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PLATE 37.—Properly cold-stored fish. (*a*) Haddocks. (*b*) Herrings. Very fresh fish rapidly frozen and *stored at −22° F. (−30° C.) for thirteen months*, then thawed, split and smoked in mechanical kiln (cf. Plates 29 and 36).

stood and a better assessment made of more recent attempts to make freezing contribute to some of the economic problems of the fishing industry.

There are two aspects of the application of freezing, firstly preservation to facilitate distribution, and secondly preservation for long term storage. The technical impasse confronting the present British distant-water white fishery was described in Chapter 10. Since it is in this case the long sea transport which results in deterioration of the fish, methods for freezing fish on ships at sea are demanded. Generally speaking, freezing at sea would permit exploitation of distant or inaccessible fisheries at present on the limit, or outside the range of the preponderating technique of chilling in ice.

In other cases, the distribution of fish on land in the frozen condition could result in an improvement in the quality on reaching the consumer. This is certainly the case with British herrings and to a lesser extent with British white fish which is already of variable freshness by the time it reaches port. This aspect is of considerable importance in countries such as the United States with warm summers and long haulage distances.

Freezing of fish for long term storage would help to even out seasonal surplus, particularly of fatty, pelagic species, such as herrings, which also, for biological reasons, vary greatly in composition, particularly in fat content, at different times of the year.

In the case of white fish, too, bad weather in winter and other factors lead to some seasonal variation in supplies and prices, and there is therefore some point in carrying stocks in the frozen state.

FREEZING AT SEA

As early as the end of last century, the pioneer firm of Hewetts', of Barking and Yarmouth (*see* p. 222), had installed a refrigeration plant of some sort on a trawler, the *Major*; but the quality of the product was so poor, no doubt for some of the reasons already indicated, that the possibility of freezing fish at sea at that time was abandoned. However, the writer of an anonymous article reviewing the history of British white fishing in 1921 'ventures to say that it is in this direction that progress may be made in the future.'[6]

In the late nineteen-twenties, Hellyers' of Hull ran two large factory ships, the *Arctic Prince* and *Arctic Queen*; and Bennetts' of Grimsby and Billingsgate one ship, the *Northland*, which brine-froze fish at sea (*see* Plates 38–40). Halibut was the main fish frozen, whilst the less valuable cod, etc. caught were mostly salted for bait. The halibut were caught on lines off Greenland by smaller vessels, 'dories', which supplied the mother ship. At the end of the summer the factory ships returned to port loaded with frozen halibut in their cold stores, and lay in dock during the winter discharging their stocks over a long period.[7] On one occasion a refrigerated carrier vessel, the *Borodino*, brought some of Hellyers' frozen fish back to Hull during the fishing season.

A Newfoundland firm, Job Brothers, of St. John's, in which the Hudson's Bay Co. acquired an interest in 1927, were also carrying out freezing operations on a floating factory, in the late nineteen-twenties.[8] This vessel, the *Blue Peter*, was of 4,300 registered tonnage, with storage capacity for 2,600 tons of fish. It brine-froze mostly salmon, halibut, and also cod, haddock, lobsters, etc., off the Labrador coast. A fleet of small steam ships and other fishing craft of 200 to 350 tons, about 125 ft. in length and 25 ft. beam, collected 'fresh' fish from fishermen using still smaller craft, until their holds were full and then delivered it to the mother ship in boxes which were hoisted on board.

Salmon were brine-frozen in baskets and packed in 100 lb. boxes for export to Britain. They took about three and a half to four hours to freeze and about twenty-five tons were frozen every twenty-four hours. In 1929, about 1,000 tons of Atlantic salmon were frozen in this ship. By 1931, however, the catch had substantially fallen, presumably at least partly owing to over-exploitation.

A little later a French company (known by its initials S.A.C.I.P.E.) tried out the alternative solution of installing freezers on the catching vessel. They built special trawlers (the *Vivagel* and *Pescagel*) equipped with freezers for 'sharp freezing' in air for the Grand Banks fishery. There was also a German venture on similar lines (the *Volkswöhl*), and even during the last war, a 190 ft. German trawler was air-freezing fillets in the Baltic for two years, heavily subsidized.[9]

All the pioneer efforts were abandoned after a few years, chiefly on grounds of cost and not, it is understood, for technical reasons. The activities of the British factory ships were having serious effects on the yield of halibut. In addition there were marketing difficulties in the case of a new commodity, particularly in the early nineteen-thirties.

Professor Harden F. Taylor, at that time President of the Atlantic Coast Fisheries Corporation, which participated along with a British and a Norwegian company in the *Northland* venture of 1928 and 1929, is still not optimistic about the possible outcome of freezing at sea.[10] 'She went to one of the largest and richest grounds in the world—the halibut grounds west of Greenland in the Davis Strait. A great many trawlers went along and we started the enterprise with great expectation of profit and success. The thing ended in a dismal failure and our company lost every cent of its $150,000 and we wrote it off and forgot it. The headaches, the personnel problems, the mechanical difficulties, the sickness, the need of doctors, the trawling problems, the running out of gear and the endless mishaps that a group of theorizing people would never think of . . . Another means has been proposed of fitting out trawlers to catch fish, fillet and freeze and do other manufacturing operations aboard the trawler. About twenty-five years ago a firm of naval architects and engineers spent two years in investigating the problem [and decided that] there were a number of reasons against it. If you give effect to the larger amount of power required to operate the freezing machinery, the room for the machinery itself, the additional fuel that has to be carried to operate both the propelling and the refrigerating machinery, the outfit that applies the refrigeration to the fish, the filleting room, and space, tables and so on, packing equipment, the additional men that would have to be carried, the room required for those people to sleep, the food for them to eat, and the room to prepare the food—all these things put together result in a very much larger operation and a larger ship with too little load—she would have too much freeboard and would not be manœuvrable as a trawler. You can either have a manufacturing plant or you can have a trawler, but you cannot have both on the same vessel.' Professor Taylor nevertheless concludes that although 'most of the experience . . . [of these attempts] to ameliorate the difficulties deriving from remoteness and perishability . . . has turned out to be disappointing . . . yet herein lie the problems that must be solved if the resources of the sea as a whole are to be fully put to use. The reason why the remote fisheries of the world are not exploited is . . . that it does not pay to exploit them.'

All these considerations serve to emphasize the magnitude of the difficulties that would have to be overcome in freezing fish at sea.

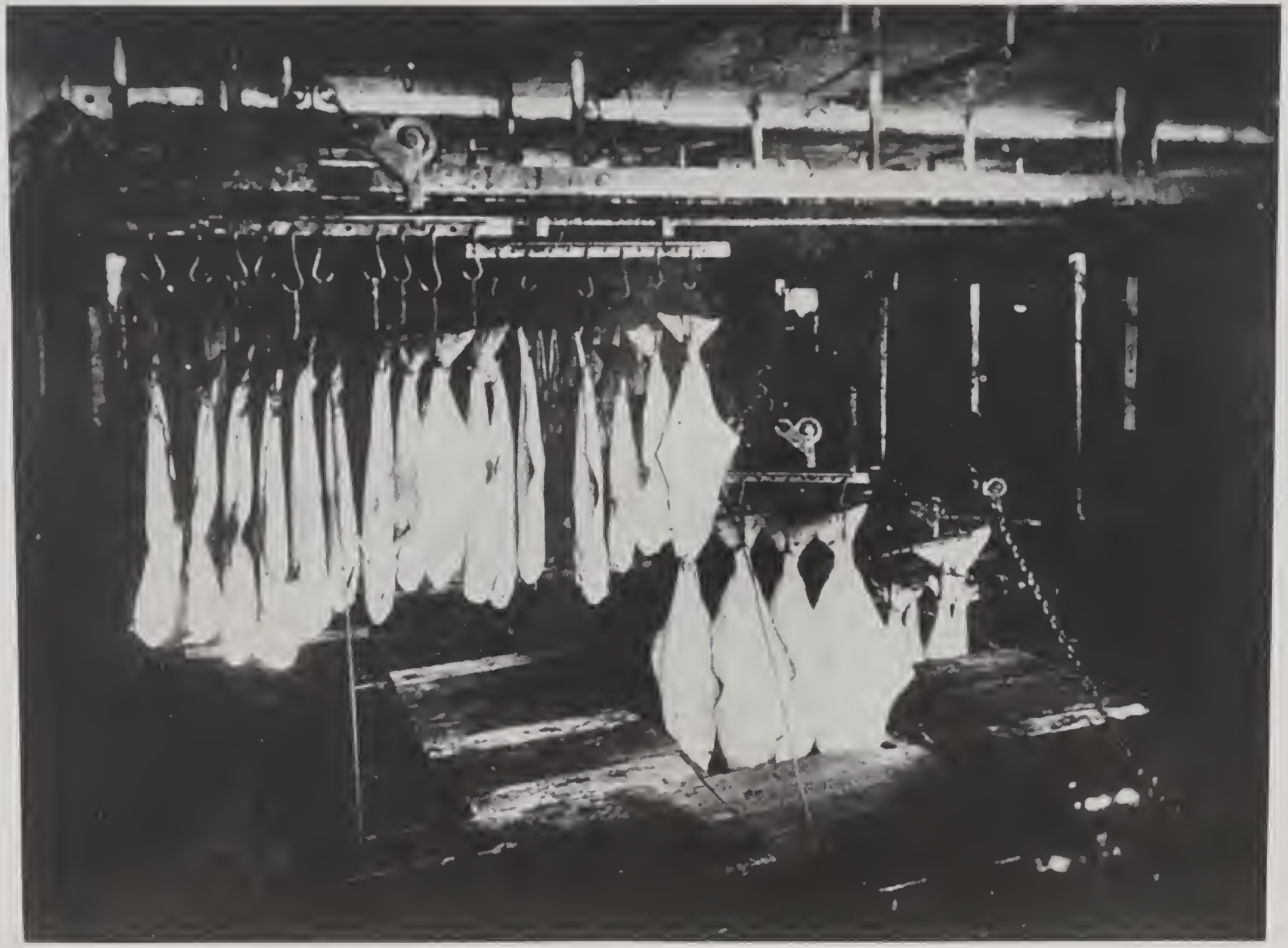
In addition, in Britain a large amount of capital is tied up in the distant-water trawlers (£18 million according to the U.K. White Fish Authority in 1952), and it is now clear that freezing at sea, unless it can be installed on existing ships, is not likely to capture the field as quickly or completely as fresh fish ousted salt fish after the coming of the railway in the middle of last century or as steam trawlers replaced sailing smacks sixty to seventy years ago.

However, it can still be said in the nineteen-fifties that there is no foreseeable alternative to freezing at sea as a means of lengthening the tether that has hampered the British white fishing industry for the past quarter of a century. Thus, the White Fish Authority of the United Kingdom in its First Annual Report in 1952 states that 'the development of a method of freezing at sea is essential if the most is to be made of' the distant-water white fishery.

There has recently been another British attempt to make freezing at sea work,[11] and after experimental trials on a converted naval ship, the *Fairfree* (*see* Plates 41–44), a special trawler, 245 ft. in length and 44 ft. in beam, has now been built for contact airblast freezing of the commoner fish such as cod etc.[12] The new vessel, named the *Fairtry*, freezes fillets continuously while fishing, carries 1,900 h.p. diesel engines and is capable of freezing 30 tons of fish a day and of holding 600 tons of frozen fillets in 7 and 14 lb. packs or 450 tons of frozen whole fish at −5° F. (−20° C.). Fish meal plant aboard the ship is capable of dealing with 12 tons of filleting offal per day, with storage capacity for 100 tons of fish meal. A machine for filleting the fish which is also carried appears to be operated successfully. Four liver boilers produce up to 50 tons of cod liver oil. The radius of operation of the ship permits trips of about eighty days, i.e. between four and five voyages per annum, cf. thirteen

By courtesy of Mr. Mark Hellyer of Hellyers (Associated) Ltd., Hull.

PLATE 38.—Pioneer British Freezing Factory ship *Arctic Queen* (1930).



By courtesy of Mr. Mark Hellyer of Hellyers (Associated) Ltd., Hull.

PLATE 30.—Halibut hanging above brine immersion freezer in the *Arctic Queen*.

to seventeen for the average trawler at present. The cruising speed is 12½ knots and the ship trawls at 5 knots. The crew is expected to number about seventy-five, who will work continuously in two shifts. The firm concerned, Salvesen's, of Leith, have had much experience of operating whale factory ships in the Antarctic seas.

Scarce and expensive fish, such as crab, salmon, and halibut (only about 5,000 tons of the latter are landed annually in Britain) can be afforded careful and special handling during freezing. On the other hand cheap and abundant fish, such as cod and herring, have to be mass frozen by labour-saving methods. Work on the development of such methods, suitable for use on a rolling ship, where stability and compactness are essential, is going ahead under Government auspices in several countries, particularly the United States, where an experimental vessel, the *Delaware* has been carrying out trials[13], and in Britain.[14] Each country has its own special technical and economic problems. There are numerous aspects to weigh up before an assessment can be made of the economic feasibility of freezing at sea in comparison with the present method of icing.

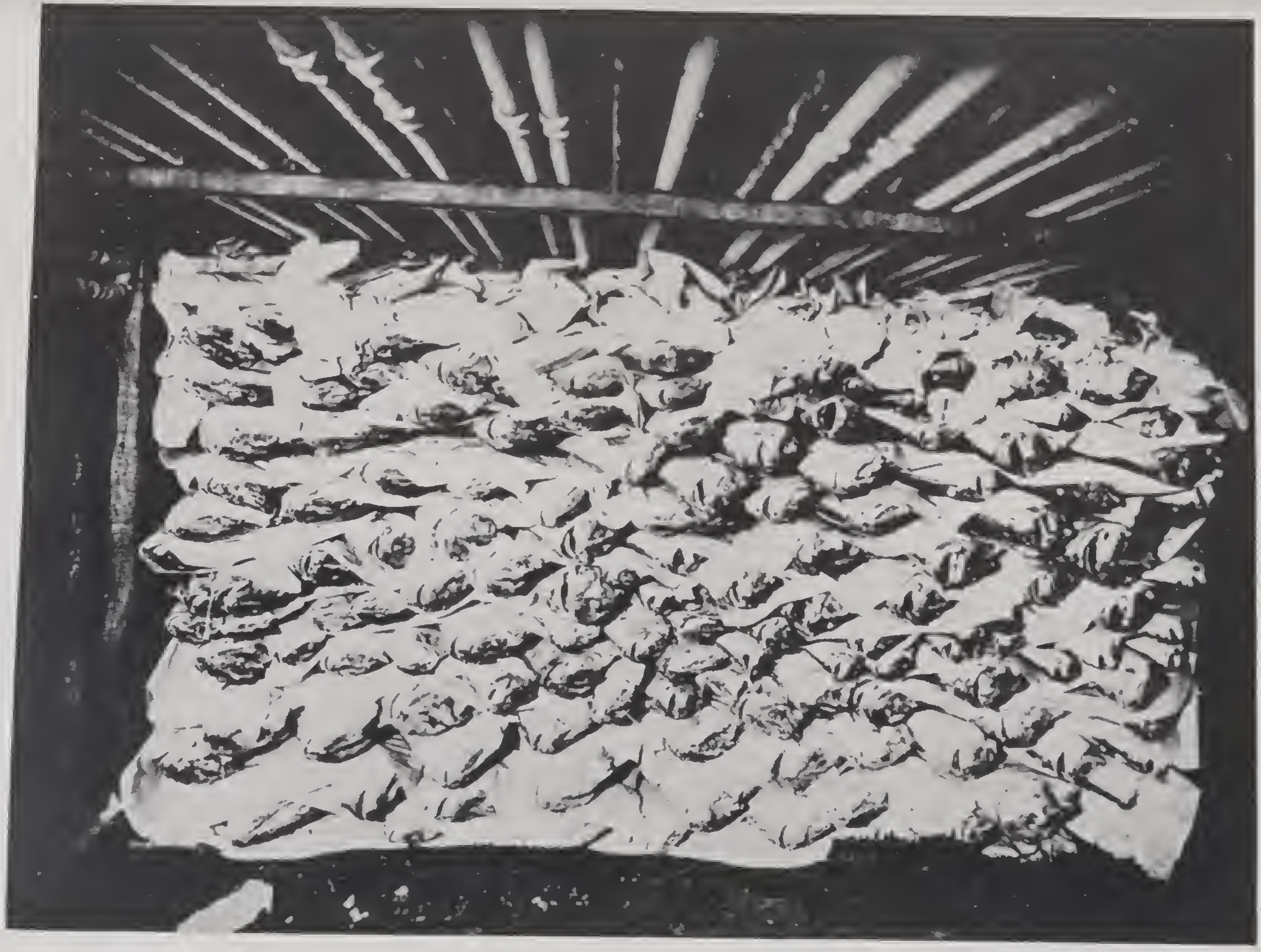
At present, a special plant, the Torry vertical plate cooler, suitable for operation on board existing trawlers, thus obviating the difficulties of a factory ship, is being developed in this country[14] for 'quick-freezing' the commoner sizes of 'white' fish as large (half cwt.) composite blocks. So far, whole or headless, gutted fish are being used, since it has, perhaps, yet to be established that there is a wholly satisfactory filleting machine. When such a machine is perfected, it will be possible to consider the freezing of blocks of fillets at sea, the heads and bones being dried into a fish meal for livestock feeding (*see* Chapter 13). Since the fish trade of this country, and of the United States, has now become dependent to an overwhelming extent on the marketing of fish fillets in fresh or frozen condition, filleting prior to freezing at sea would present obvious advantages over thawing whole fish and then filleting. British experience has been that the freezing of fillets yields a less satisfactory product than freezing the whole fish and filleting after thawing. Recent experiments by United States government scientists and engineers have however indicated that a product acceptable to them can be produced by refreezing the fillets obtained from thawed fish after freezing whole fish at sea. Canadian workers have also been experimenting once again with brine freezing of whole fish on the Pacific coast.[15]

Ships driven by diesel instead of by steam may have more room for refrigerating and other plant; and trawling over the stern, tried by the *Fairfree*, would provide valuable between-deck space that is lacking in the typical low-waisted trawler of to-day. Since it is difficult and dangerous, though not impossible, to transfer fish from a catcher to a factory ship in the open ocean in all weathers, it seems at present that the development of a self-contained catching and processing vessel will be the more fruitful line to pursue. At the same time, unless the freezing trawler is to remain longer at sea than an ordinary trawler, there will be no economies in the proportion of time spent as a transport (*see* Table 4) for fish and crew.

'Quick-freezing' followed by low-temperature storage maintains the quality and therefore the value of the fish. In a normal market iced fish fall much in value as they become staler. As mentioned in Chapter 10, present methods of bulk stowage in the hold result in the fish being under pressure at the bottom of each section of the cargo, so that it may lose up to 15 per cent in weight. In addition to the economic loss, the juice thus expressed carries away a proportion of the nutriment and flavouring bodies. Moreover, because of the perishability of the cargo, ships have been returning from the distant grounds before they were full. In addition, once again, as pre-war, voyages are being deliberately curtailed for economic reasons.

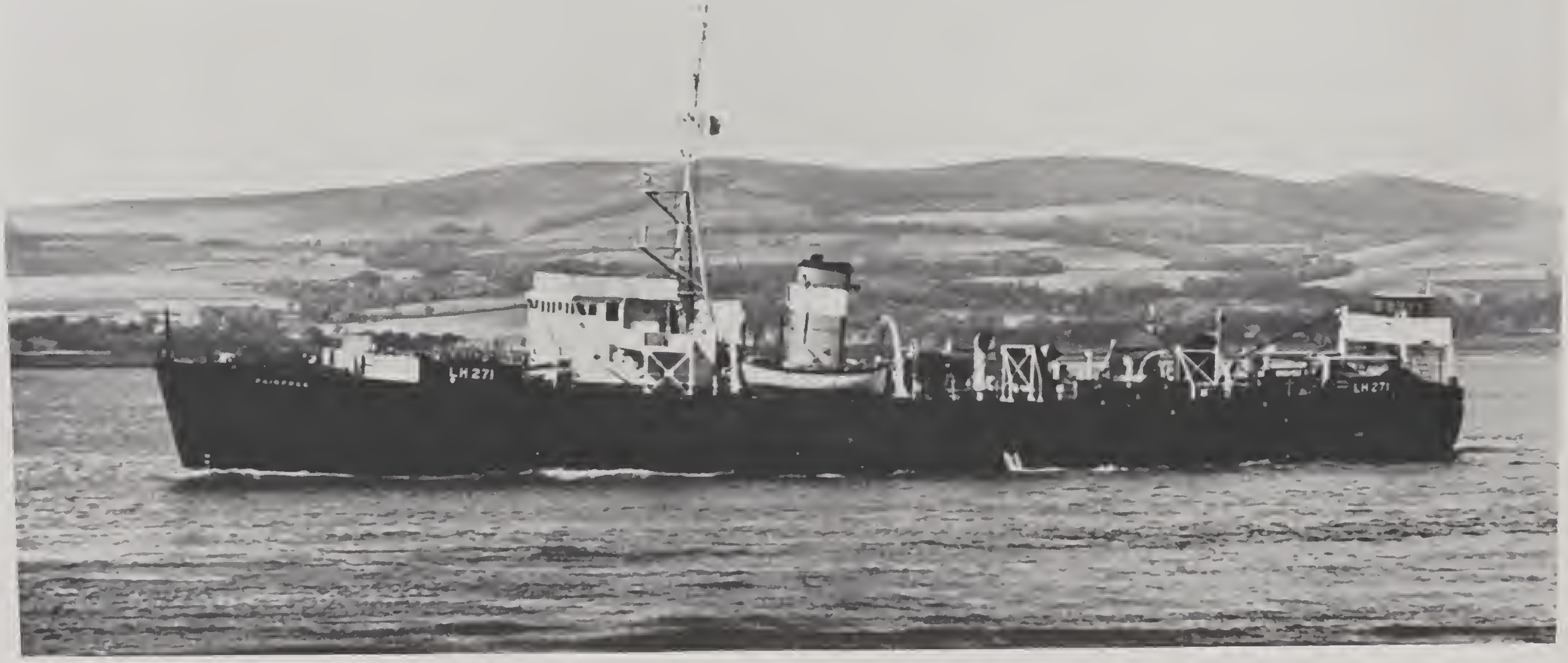
In 1951, the 413,000 tons of white fish landed by 3,783 trips from distant waters represented only 59 per cent of the rated fishing capacity of the fleet.[16] In addition, there are problems arising chiefly from the irregularity of landings because of the difficulties of anticipating the rate of catching and the time taken on the homeward voyage.

The use of freezing on trawlers or factory ships might therefore improve efficiency as well as quality, and even perhaps increase landings. Pay and conditions of work would have to be such as would attract men to go on longer voyages, particularly to the Arctic with its cold and dark winter. In the case of a relatively imperishable article like properly frozen and stored fish, distribution either at home, or if necessary abroad, could



By courtesy of Mr. Mark Hellyer of Hellyers (Associated) Ltd., Hull.

PLATE 40.—Frozen halibut stacked in cold store of the *Arctic Queen*.



By courtesy of Chr. Salvesen & Co. Ltd., Leith.

PLATE 41.—T.S.F.V. *Fairfree*, factory-ship fishing vessel.

be rationally and more economically planned, and freshest fish of all sorts made available all the year round, subject to natural availability. Thus, cod is by far the most plentiful species of 'white' fish, and it must be realized that any monotony of diet is liable to set a limit to the level of consumption. However, as the White Fish Authority points out, 'the success of this policy will depend upon an increased consumption of frozen fish, which should not be difficult to achieve especially as fish frozen at sea would be greatly superior to fish frozen at the beginning of a fishing voyage.' The O.E.E.C. report (*see* p. 269) emphasizes that 'although freezing, more than the present system of cooling, offers greater possibilities for preserving the freshness of fish, consumers in most European countries have little taste for frozen fish products . . . due to unfortunate experience in the past when the quality of frozen products presented to the consumer too often has been of a low standard, because technical possibilities of freezing have manifestly not yet been fully utilized.'[17] Despite the greater dependence of the United States on frozen fish, the American consumers' reaction seems to be similar.

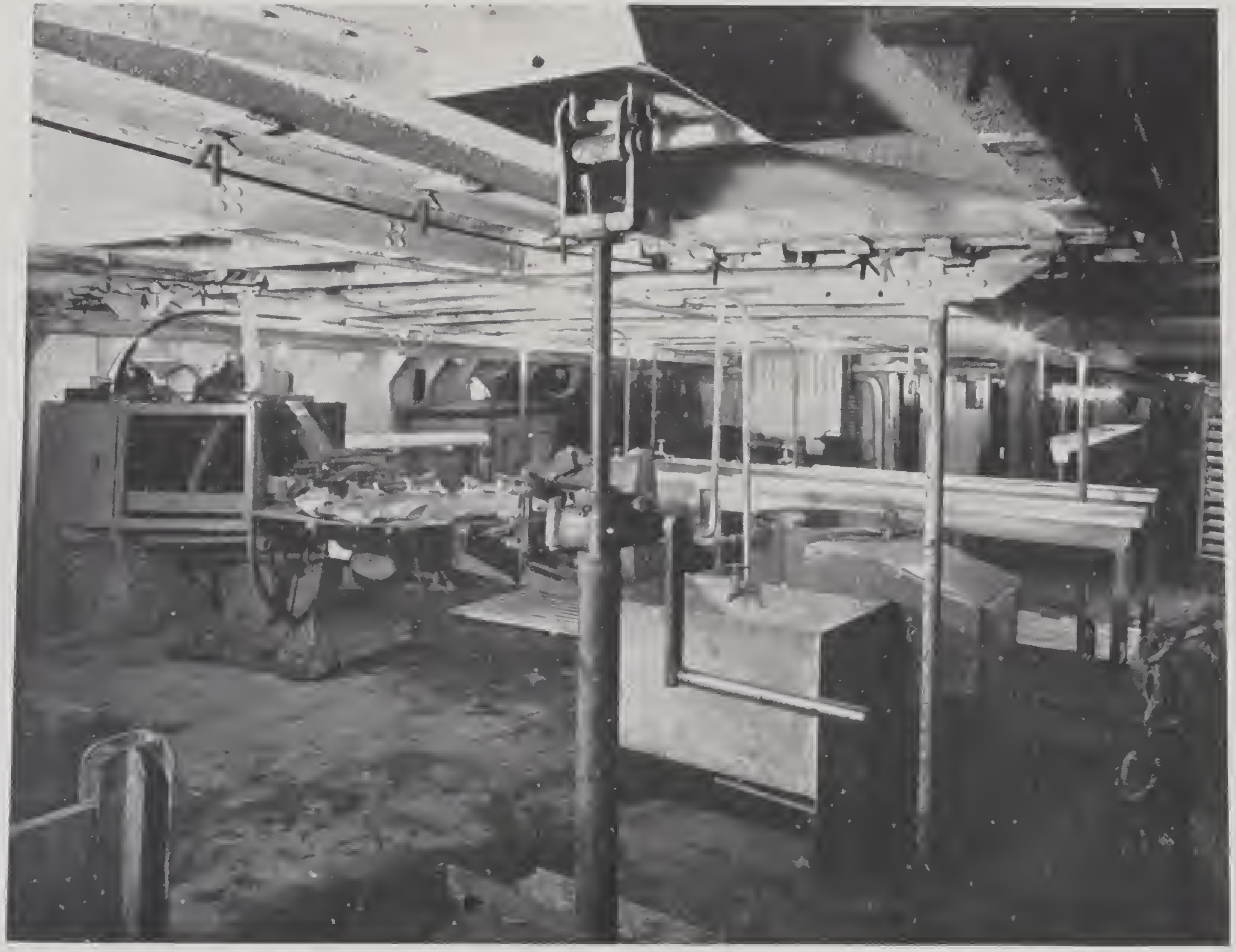
The solution of the problems of freezing at sea will obviously have widespread application throughout the world, as is shown by the fact that Britain, Germany, France, the United States, Newfoundland, and Japan have all carried out experiments on the full commercial scale.

Thorough-going freezing at sea has far-reaching implications. For one thing it can revolutionize the distribution of fish, because refrigerator ships can be run straight into large ports, such as Liverpool and London, by-passing the existing fishing ports, with all their ancillary industries such as fish processing, ice-manufacture and box making. At the same time, it is highly likely on the short term that any developments along these lines within the industry will be based on the facilities of the existing major fishing ports. It is conceivable that ports such as Aberdeen, which are far from the main centres of population, may then be at a serious disadvantage. On the other hand, if freezing can be successfully carried out on the trawler itself, then it might be cheaper for it to unload its frozen cargo at a northern railhead than to immobilize equipment and crew by steaming up and down the North Sea to the Humber ports. However, there are human and social difficulties facing any attempt to uproot crews and their families in this way.

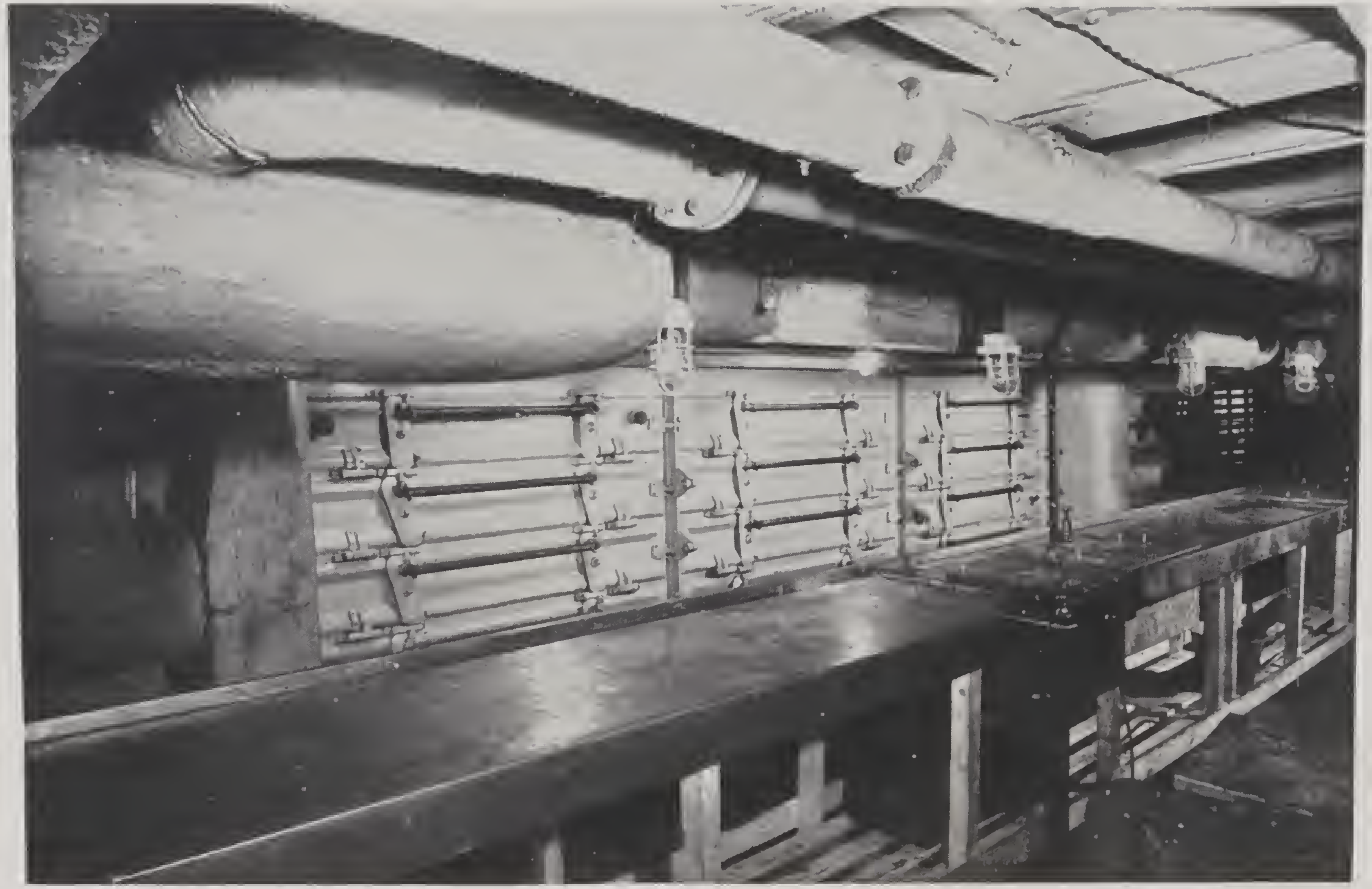
The tuna clipper fishery of the South Pacific coast of the United States provides the only successful example hitherto of freezing at sea aboard the fishing vessel.[18] These clippers are 100 ft. to 150 ft. in length, carrying, respectively, 175 to 500 tons of frozen tuna. The largest ships take up to sixty days to complete their cargo and cruise as much as 2,500 miles as far as the Galapagos Islands on three-month trips. The fish is first cooled down to its freezing point of about 30° F. (−1° C.) by immersion in tanks of chilled sea water for a day or two, then frozen in strong brine down to a temperature of about 18° F. (−8° C.). After at least forty-eight hours, the brine is pumped out of the tanks, which are fitted with cooling coils, and the fish are stored in air at a temperature of about 12° F. (−11° C.). A day or two before reaching port the fish are partially thawed by circulating sea water through the tanks.

For shorter voyages to coastal waters, purse seiners partly freeze their catch of tuna by refrigerating the hold with direct expansion coils to a temperature of 20° to 25° F. (−11.5 to −9° C.). However, special conditions apply in this fishery which permit the use of the relatively simple procedure just described without the objectionable results it would have in normal circumstances. For one thing, the tuna is a fish with especially firm flesh which can stand up to and indeed benefit from the softening that occurs during slow freezing, and it is used exclusively for canning (*see* p. 199), in which the skin which would often be discoloured is invariably removed and some salt is in any case added for flavouring purposes. In addition, the prolonged steaming that tuna flesh receives prior to canning allows juices to escape, carrying away, perhaps, some of the 'off' flavours produced by the first stages of decomposition and fat oxidation. However, it has been reported that a tuna clipper has also been used successfully as a freezer mother ship and carrier for salmon. Freshly caught salmon taken over from fishing boats in the river mouths in Alaska, were frozen in the ship's well in the manner just described.

Just after the war, on the north Pacific coast of the United States, experiments were carried out by the National Recovery Corporation in the specially constructed *Pacific Explorer*, using



By courtesy of Chr. Salvesen & Co. Ltd.



By courtesy of Chr. Salvesen & Co. Ltd., Leith.

PLATE 43.—The *Fairfree*. Freezer and packing table.

an air-blast freezer for tuna and a refrigerated-shelf freezer for halibut and salmon. Freezing times were anything from eight to sixty hours, depending on the size of the fish. This vessel was of 8,800 tons displacement and 410 ft. long, carried 240 men and went on trips of up to four months at a time. It was capable of freezing 260,000 lb. of fish per day, as well as making 10 tons of ice, and could can 100 cases of crab. It produced 50,000 lb. of frozen fillets in an eight-hour day as well as reducing five tons of offal per hour. For various reasons the trials were discontinued in 1947.

More recently another factory ship, the *Deep Sea*, has been operating successfully in the Behring Sea, blast-freezing cooked crab meat; and shrimp is yet another luxury product which perhaps can well stand the added cost of freezing.

Freezing factory ships also operate on the Caspian Sea, where conditions must be very different from those associated with trawling in the open ocean.

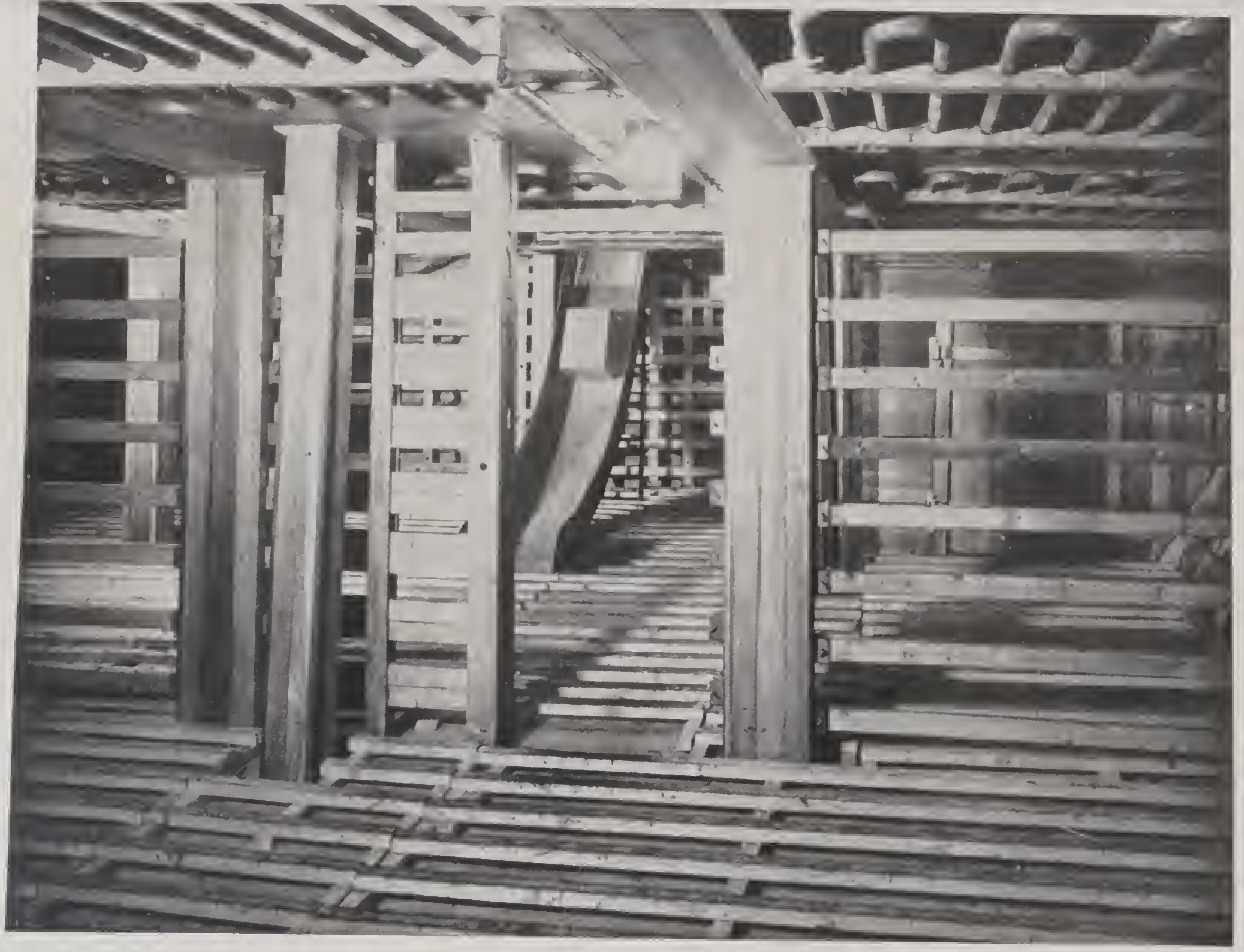
FREEZING ON LAND

Although freezing at sea, apart from the isolated experiments and instances already noted, is not yet established as a going concern, freezing on land has been carried out with some degree of success on an increasing scale since the late nineteen-twenties in the large, economically advanced, continental countries, such as the United States and Canada,[1] and in countries such as Norway and Iceland which supply them. The latter, being situated very close to rich 'white' fishing grounds, are in a position to freeze the very freshest of fish on shore.

Herrings were frozen for bait in the first freezing plant built in Norway about 1920. The fish were frozen in wooden boxes by means of cold, circulating brine, trickling over them. This system, with modifications, is still predominant. From about 1930 onwards an increasing quantity of these frozen herrings was exported to European markets for human consumption. In the crude freezing process, the freezing is slow and the brine is not washed off the fish in a 'glazing' process. As a result, the product must soon become very rancid.

Although freezing practice in the early days did not, for the reasons already given, yield a product as good as fresh fish, recent research has made this a practicable proposition.[5,19] Rapid freezing and especially low temperature storage (at −4° to −22° F. i.e. −20° to −30° C.), are required if fresh fish is to remain practically unchanged after three to six months' storage. Commercial practice has not, in general, caught up with these recommendations.[20] As a result, the average quality of fish in countries such as the United States, where the long distances that have to be covered during distribution and the high summer temperatures met with in the interior of the continent have led to greater dependence on frozen fish than is yet the case in western Europe, is not generally as high as the latest scientific and technical evidence, and the operations of the best plants based on it, have shown to be attainable practically. Even in 1946, although quick-freezing of fish in plate freezers was quite common, a considerable quantity of fillets was still being sharp-frozen in twenty-four to thirty-six hours either in boxes or metal pans on shelves of refrigeration coils maintained at −35° to −40° F. by direct ammonia expansion, with an atmospheric temperature of about −20° F., or else in wooden boxes in 'air blast' chambers at temperatures down to −35° F.[21] However, already in 1925, 45,000 tons of fish were being frozen. In 1930, 15 per cent of the total United States and Alaskan Pacific salmon catch was frozen, compared with 65 per cent canned, 5 per cent smoked, and 15 per cent marketed in the fresh condition.

Most of the frozen fish that is marketed is in the form of frozen fillets. Filleting at the ports began in 1921, and grew rapidly, so that there were 40 plants in 1924 and 128 in 1930. By 1940, 50,000 tons of fillets were produced, compared with 7,000 tons of steaks and other edible portions. By 1951, 50,000 tons of fillets were being packaged and frozen annually; most of this came from the Atlantic. Seventeen per cent consisted of haddock and 60 per cent was 'ocean perch', a species of *Sebastes*, or 'red fish', similar to the Norway haddock, or *berghylt* as it is sometimes called, landed at the distant-water ports of England. The fishing for this latter species off the New England states has developed from practically nothing in the past quarter of a century owing to the development of this outlet in the form of fillets which are now largely frozen. Machines have been devised for the various operations of heading, filleting and skinning cod, haddock, and red fish, and now form a regular part of the pro-



By courtesy of Chr. Salvesen & Co. Ltd., Leith.

PLATE 44.—The *Fairfree*. Cold storage room, showing chute.

cessing lines, which are mostly adapted to belt conveyors, instead of the tables still usual in this country.

It can therefore be said that freezing is now, next to canning, the pre-eminent process of long-term preservation in the United States. In 1940, the total of all fish frozen was 5 per cent of the total catch or 7.5 per cent of that portion used for human food. Since at least 26 per cent of this was frozen in the form of fillets, allowing 60 per cent for offal, the true percentages are 7 and 10.5 respectively.[21]

Freezing has only fairly recently established itself on land at the major British white fish ports. In Grimsby it is recalled that about 1929, Mr. Alf Bannister, who died in 1931, paid a visit to France where it was reported that hake was being frozen very successfully. However, it was not until a year or two before the outbreak of war in 1939 that systematic quick-freezing was developed by a number of 'go ahead' firms at the principal ports. The equivalent of 30,000 to 40,000 tons of fish per annum has been frozen in recent years. The total amount of fish 'quick-frozen' in the United Kingdom in 1951 was 18,152 tons, made up of white fish 14,410 tons (mostly fillets and therefore representing at least twice as much whole, gutted fish); herring 2,908 tons; mackerel 432 tons; and milts and roes 402 tons. However, this practice of freezing at the port, although admirable for herrings,[19] cannot significantly improve the general freshness of the white fish reaching the consumer. Only freezing at sea immediately after catching can do that and it is certain that a way will eventually be found. In the event of the establishment of successful freezing at sea of the distant-water fish, no doubt icing will still serve a purpose for buffer storage as well as for preservation of near-water fish in the usual manner.

Freezing promises to be the predominant method of preservation of the future in the way that chilling in ice is in industrialized countries at present and salting was in the past.

The successful development and establishment of a large-scale fish freezing industry demands special facilities for storage and transport of the product during distribution. Large cold storage depots and refrigerated sea and land transport are required.

Sea transport of frozen fish from the Arctic countries to the European and United States markets is being developed. In

Norway, since the second World War, more than twenty vessels have been specially built with equipment for maintaining temperatures below −20° C. Iceland has five refrigerator ships built since the war and one pre-war vessel with a total carrying capacity of about 6,000 tons, sailing from Iceland to Europe or the U.S.A. Between thirty and forty cargo liners on various routes have also had compartments maintaining −4° F. (−20° C.) installed for the carriage of frozen fish.

For land transport, cooling of insulated rail vans with eutectic ice and solid carbon dioxide has been tried, as also have compressors run either off the wheels or, better still, by their own prime movers. A suitable type of petrol engine for the latter purpose has been tested out in Canada. Regular air transport, refrigerated or otherwise, is not likely for a long time to come except for luxury products (e.g. lobsters) owing to its very considerable expense.

FUTURE DEVELOPMENTS

The question may be asked whether any revolutionary developments are possible in fish freezing. Although it is always unwise to be categorical about the future on the basis of present knowledge, it is tempting to cast doubt on the possibility of any great advances towards absolute perfection. Experiments on freezing fish in an air blast at −80° F. (−62° C.), or even in liquid air, in which freezing takes only a matter of seconds, have not shown the product to have any remarkable improvement over normal 'quick-freezing'. With regard to storage temperature, since it has already been established beyond doubt that as this is lowered there is a general and continuous retardation of adverse changes, at least, down to about −25° F. (−31.5° C.), it is necessary to consider whether the effects of still further lowering would be expected to be even more beneficial.

On general grounds, it would be expected that biochemical and enzymic effects would continue to be still further retarded and ultimately suspended at a low enough temperature, so that an indefinite storage life in even more perfect condition might result.

Mention has been made of the idea formerly held, that frozen fish could in fact be damaged if held at 'excessively low' temperatures. This belief has certainly been disproved for temperatures down to −25° F., but the ideas underlying it perhaps require consideration in this context. Even at −25° F. fish is not frozen absolutely solid, no matter how firm it may appear. There is still present 1 or 2 per cent of fluid, consisting of a residual 'mother liquor' of the natural salt mixture present in tissue fluids, from which most, but not all the water has crystallized out. This does not set entirely solid until it reaches its 'eutectic point' in the region of −60° F. (−51° C.) Although this strong salt solution has a 'denaturing' effect on fish protein, even at −25° F., it is nevertheless possible that it provides some 'cushioning' for the expansions and contractions that have taken place. Since ice is about 8 per cent more bulky than water, freezing is invariably accompanied by an increase in volume. The stresses and strains thereby produced may account for some of the slight damage to texture produced during freezing, which results in 'drip' formation, etc. On the other hand, lowering of temperature causes substances to contract. It is therefore just conceivable that greater strains may be produced by subjection to ultra low temperatures than at 'moderately' low ones of, say, −20° F. (−29° C.) and that greater disorganization of structure might result.

In any case it seems that for all practical purposes, the high quality of frozen fish obtainable by a proper application of present knowledge to commercial practice does not leave much margin for future improvement.

One possible trend that has not yet been mentioned is the freezing of cooked fish and fish dishes which merely require warming up to be ready to eat. This procedure is already being used on an increasing scale by some of the larger food manufacturers and *restaurateurs*. If generally adopted, a further all-round lowering in storage temperatures to, say, −40° F. (−40° C.), may be necessitated for maximum retention of the quality of made-up dishes for reasonably long periods. However, since, like canning, this practice pre-determines the form in which the fish is to be consumed, even though giving a wider variety of choice than canning, it seems more than likely that most fish will continue to be frozen in the fresh rather than the cooked state.

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Chapter 13

FISH MEAL AND DEHYDRATION

The artificial drying of fish and fish waste to produce a meal for use as fertilizer and livestock fodder is not strictly a method of preservation in the sense of storing for subsequent human consumption. Nevertheless, the products of improved methods of 'dehydration' (*see* later) are capable of being used for human food and further large-scale developments in this direction are likely in the future. The manufacture of fish meal arose from the widespread, direct application of fish as manure to the land and, later on, the similar use of the residue from the fish body oil extraction industry. Fish oils have already been referred to from time to time (*see* pp. 57 and 97) but exhaustive discussion of this subject is outside the scope of this work.

The value of fish and fish waste as a fertilizer and as an animal food was known in early times. Thus the use of small sun-dried fish as a food for domesticated animals is mentioned by Herodotus (*see* p. 50) and Marco Polo (*see* p. 49) found the same practice common on the coasts of the Arabian Sea. Although in Siberia fish and offal had long been sun-dried before being applied to the land, the special mechanical treatment of fish and fish waste to produce nitrogenous fertilizer and animal feeding meals is, generally speaking, a product of the industrialized agriculture of the nineteenth century, particularly in the United Kingdom, United States, and Germany. In the United States it was principally the fatty fish surplus to requirements and not much favoured for human food that were used for agriculture and later for stock feeding. In the United Kingdom, Germany, and France, on the other hand, it was mainly surplus white fish and offal resulting from their extensive trawl-fishing industries that supplied the raw material. These two types of raw material demanded substantially different processes, and the oil from the one was, for a long time, regarded as the more valuable product, while the residue of flesh and bones was only a by-product.

The methods first described for the extraction of oil from fatty fish and fish waste on the New England coast were extremely crude, depending on putrefaction to break up the flesh and release the oil as did the first methods for obtaining seal oil and cod liver oil (*see* p. 151).

MENHADEN

The menhaden caught off the Atlantic coast of the United States was used as food by the early colonists, and also as bait for cod, etc. In addition they learnt from the Indians to fertilize their crops with it. Until the early part of the nineteenth century, menhaden was still used practically entirely as a raw, whole fish fertilizer. Even in the middle of the century, according to Professor Brown Goode's standard work on *The Fisheries and Fishery Industries of the United States*,[1] published in 1884, large quantities of menhaden were ploughed into the soil of farms along the shores, stimulating crops for a while, but in time having a detrimental effect, owing presumably to the accumulation of fish oil, 'burning up' the ground, as they put it.

It seems that the oil was first separated from the flesh of menhaden in Rhode Island where, during the war with England in 1812, paint oils became very scarce and fish oil was tried. 'The first method was to . . . put them in large casks . . . salt water was added to cover them and boards, weighted with stones put on top of the fish to press them down. The fish were then left to rot for a few days, after which they were thoroughly stirred with a long stick daily to break up the fish and liberate the oil, so that it might come to the surface of the putrid mass. This process was kept up for from two to three weeks, the oil being dipped off daily.'

About 1820, they commenced boiling the fish in large kettles, stirring them frequently and skimming the oil off by hand. Among the first to do this, perhaps as early even as 1811, were Barker and John Tallman, who set up two small iron pots at Portsmouth. The fish were covered with water and boiled until the breakdown of the fleshy tissue released the oil. The boiled mass was then poured into containers and pressed by weighting with rocks placed on boards laid over the solid mass. When the oil floated to the top of the water, it was skimmed off and barrelled for shipment to the New York market. Two more pots were added in 1814, but next year gales destroyed the apparatus, and business was not resumed until 1818. In 1824, a cooker was set up consisting of a wooden tank, 5½ ft. high, 6 ft. wide and 8 ft. long, heated by a copper flue-pipe from a furnace located at one end.

The 'factory' was built on skids and hauled by two oxen to a farm a mile away where, after the oil was recovered, the water and scrap were broadcast as fertilizer. Whereas one account has it that steam was first used for cooking about 1830, another says that live steam was first used by Tallman in 1841 at an installation consisting of eight wooden tanks each holding sixty barrels of fish.

The fish were thoroughly cooked and stirred and after standing for a time the oil was skimmed off and a plug pulled from the bottom of the tank, allowing the whole mass to run off on to the ground. This residue had a ready sale as manure for farmers. Some time between 1835 and 1840, the scrap was pitched on to an inclined platform and allowed to drain under its own weight, thus yielding additional oil and at the same time improving its value as manure.

In 1842, Tallman and Lambert built a plant at the mouth of the Merrimac River, Mass., and soon after, Daniel Wells built a similar factory on Shelter Island, near Greenport, Long Island, New York.

About 1855, the first crude lever press was constructed here, and about this time, too, Charles Tuthill, of Greenport, is reported to have invented an improved method of expressing oil from the cooked fish. Three years later the first steam works with hydraulic presses was erected at Greenport. At first very coarse manilla cloths or blankets were used for pressing at 80 to 100 tons pressure.

In Maine, the menhaden oil industry started up rather later, and developed Similarly Mr. E. B. Phillips reported that: 'In about 1850 I was in the fish-oil business in Boston. An elderly lady by the name of Bartlett, from Blue Hill, Maine, came into my store with a sample of oil which she had skimmed from the kettle in boiling menhaden for her hens . . . I promised $11 per barrel for all she could produce.' He also fitted her out with kettles for boiling the fish. 'Her husband and sons made thirteen barrels the first year and the following year one hundred barrels.' Since much oil was thrown away with the scrap, pressing was soon suggested. At first the fish were placed in a common iron kettle with a heavy cover and a long beam for a lever; afterwards by placing it under the weight of heavy rocks in barrels and tubs perforated with auger holes. Phillips subsequently fitted out some fifty families on the coast of Maine with presses of the screw and lever type for the production of oil on this domestic scale. The first factory was set up there in 1864 and there were eleven in action by 1866, all using steam for cooking the fish and operating the presses.

The industry then expanded considerably, and plants were established all along the Atlantic coast from Maine as far as Portsmouth Island, North Carolina, where northern soldiers returning home after the Civil War reported an abundance of fish and encouraged northern capitalists to invest in the fishery. However, the fishery was still being prosecuted almost entirely for the sake of the oil. In Maine, even as late as 1864, the pressed scrap was often either thrown overboard or given to farmers for the price of hauling it away.

However, the possibilities of improved utilization of the residue after extraction of the oil were beginning to be recognized. It was reported that in the Faroe Islands, whiting, presumably unutilized whole fish including livers, were first used for the extraction of oil, giving a yield of 1½ to 2 per cent only, and the resulting white fish press cake was dried at steam heat, ground fine and packed in air-tight cases for sale as manure.

W. D. Hall of Wallingford, Connecticut, who was engaged in the bone boiling and tallow rendering business, and tried to patent in 1852 or 1853 a process of steaming fish and extracting oil, although its priority was challenged, also took out a second patent for drying the fish scrap on platforms by solar heat (*see* Plate 45).

In 1880, procedure for making menhaden oil in the larger works was as follows. The fish were first dumped into cooking tanks filled 6 in. deep with sea-water, fifty to seventy-five barrels of fish in each. The steam was turned on and the fish boiled for half an hour or so, thus separating about two-thirds of the oil. The remainder was expressed by hydraulic steam-presses of 50 to 150 tons capacity. The fish were placed in circular vessels

By courtesy of the Government Printing Office, Washington, D.C.

PLATE 45.—Menhaden oil and meal factory (about 1880). Note platform for sun-drying the press-cake. *From* The Fisheries and Fishery Industries of the United States *by G. Goode Brown*, 1884.

of $\frac{1}{2}$ in. iron, perforated with holes $\frac{1}{8}$ in. diameter, each with a capacity of three to ten barrels. The scrap was dumped into a cellar below, from which at some factories, at Greenport, for example, it went into 'steam drying machines'. The oil and water were run into drawing-off tanks while still hot. The oil was drawn off into settling tanks of 4,000 to 5,000 gallon capacity, where it remained for some hours, long enough to allow the impurities to sink to the bottom, but before this sediment began to putrefy, the oil was pumped by steam to bleaching tanks of several thousand gallons capacity, where it was exposed to the rays of the sun for one to two weeks (or for some hours only in a broad, shallow tank) to clarify and whiten, after which it was ready for shipment. Oil made from early season's fish was said to be not as good as that made later on, being 'weaker' and commanding five cents less per gallon, no doubt connected in some way with its degree of chemical unsaturation. There were several floating factories situated in old hulks along the New England coast.

In Maine alone in 1876, 709,000 barrels of fish yielded over 2 million gallons of oil and 21,000 tons of crude guano. In the more southern States, 827,000 barrels of fish yielded just under 1 million gallons and 30,000 tons respectively. It was calculated that the refuse products of the oil factories, together with fish used in the crude state for manure, represented 10 million lb. of ammonia, equivalent to 60 million lb. of Peruvian guano, as well as 1.4 million lb. of calcium phosphate.

The oil was used chiefly by the tanners for 'currying', or softening leather, as well as for paint. The refuse from the cooking tanks and settling tanks, dried and ground, totalled 64,000 tons in 1880, worth $1,300,000. By 1877, the use of whole fish as fertilizer on the land had almost entirely ceased, especially in Maine, which, as has been shown, was the principal producer of menhaden oil, and had the advantage of the oiliest fish.

It will be seen that fish meal at this time was still being thought of in the United States, the principal producer of fish body oils, only as a fertilizer for application to the soil. The same was true of white fish offal. Halibut heads, bones, etc., which contained some oil, were thrown into a large tank, treated with steam until thoroughly boiled, and then placed in an open cylinder and the oil crushed out by means of a hydraulic press. The yield was about forty gallons per ton of heads, and it also was used by leather curriers. The heads of the non-oily cod when caught relatively close to the shore were kept for feeding, chiefly to pigs. The rest were thrown overboard. The use of dried fish scrap as a food for domestic farm animals was, however, being urged, and it seems probable that farmers in Europe and even some in parts of New England may already have been doing this.

Properly conducted trials to test the value of fish waste in the rations of domestic livestock have only been recorded in comparatively recent times. In 1875, Kellner reported some experiments of Weiske in Germany on the use of fish residues in the feeding of sheep. In 1892, the Norwegian government made the first large-scale feeding trials to ascertain whether fish waste, after conversion into a dried meal, was a suitable food for farm animals. The success of these experiments soon resulted in fish meal achieving a notable popularity among Continental farmers. By 1902, the new product was being fed in Germany to nearly every class of domestic animal, including dairy cows, with highly satisfactory results. 'In this country, however, the farmer displayed as yet no inclination to use fish residues for feeding purposes, preferring to employ them in the traditional way by applying them to the land as a fertilizer.'[2]

THE FISH MEAL INDUSTRY IN BRITAIN

The value of fish as fertilizer had long been realized in Britain and it was a common thing for surplus fish in times of glut to be taken from the coast by farmers and dug into the land. For example, that early version of a trawl net, the 'wondrychoun', used in the Thames estuary as early as 1376–7 (*see* p. 217) was accused of such devastation that 'the fishermen . . . take so great abundance of small fish . . . that they do not know what to do with them, but feed and fatten the pigs with them.' Again, Defoe writing in 1724 of Bridport, notes that there were officers on the shore from the towns round about 'to prevent the country farmers buying the mackerell to dung their land with them, which was thought to be dangerous, as to infection.'[3]

Prior to the coming of the railway to Grimsby in 1848, practically all the fish taken locally from the Humber estuary was used to manure the fields of Lincolnshire.[4] Grimsby seems to have been the first port in Britain to have processed waste fish, soon after its inception as a white fish trawling port in the middle of the century.

In the late eighteen-fifties, firms of cartage contractors in Grimsby were still buying waste fish on the markets for selling to farmers in the raw state as fertilizer. It was simply dumped on to the land and ploughed in. By 1860, a Grimsby firm of timber merchants, Bennett and Sons Ltd., of which the manager was William Bennett, had started a crude process of drying this offal for subsequent application to the land. The business was sold in 1911 or 1912 to a Glasgow firm who sold it again to C. and T. Bowring, a firm of fish oil manufacturers who are still prominent in Grimsby.

The next firm to start up was John Miller and Co. in Aberdeen in 1880. Their works (Sandilands Chemical Works) subsequently became absorbed by Scottish Agricultural Industries Ltd., a section of I.C.I. Ltd.

Another factory was started up in Grimsby in 1881 by a manure merchant, W. W. Dawson, and this was taken over by the Grimsby Manure and Oil Co. in 1886. Mr. E. L. Richardson was appointed manager of this firm in 1909. Later, in the thirties, he became the first secretary of the Fish Meal Manufacturers' Association, and his personal reminiscences of the early days of fish meal manufacture have been largely drawn upon by the author for this section. In 1916, the firm was purchased by Goodrich Products, of which Mr. Richardson was the managing director. About 1932 the firm was amalgamated with six or seven other firms in Grimsby to form the Grimsby Fish Meal Co. Ltd.

At Aberdeen again in 1890, the Aberdeen Fish Manure and Oil Co. was formed with a factory at Cove, Kincardineshire, about six miles south of Aberdeen; the ruins of the factory can still be seen from the main railway line.

About the same time, the North of Scotland Fish Guano and Oil Co. was founded, the manager of which was Mr. Crombie. This firm later became Mutual Fish Products in 1930. There was yet another plant in Henderson Street, near the Aberdeen fish market, which was bought by the 'Mutual' and then sold to the Caledonian Milling Co., who thereupon started up production in competition in 1932.

At Hull, prior to 1891, there were three or four firms collecting fish offal, e.g. Hunters of Stoneferry, Hart and Grindham, and Jackson and Sons. These had a short life, however, and in 1891, what was later called the Hull Fish Meal and Oil Co., was formed in the interests of the trade as a co-operative concern by local fish merchants who were the source of most of the fish offal used as raw material. Larger, guaranteed supplies of raw material encouraged the installation of new machinery. Grimsby Fish Meal Co. now functions on the same 'mutual' basis.

In London, the British Feeding Meals and Milk Products, Ltd. was formed in 1912 by a merger, including the Premier Fish Meal Co., which was formed by a number of Billingsgate fish merchants. There also appears to have been a company in existence there prior to this date. Fish meal factories had also been set up by this time at Fleetwood and Milford Haven, and later at North Shields, the principal remaining steam trawling, white-fishing ports.

None of these factories existed solely on surplus fish. The raw material used was various fish trimmings, heads, etc., of white fish and in the early nineteen-twenties, when filleting at the port became common, and with the increased supplies then being landed by the distant water trawlers, there were greater quantities of fish offal, i.e. heads, bones and skins, the latter also being used for making fish glue.

The earliest types of fish dryers were the so-called 'concentrators', consisting of a cylindrical, steam-jacketed drum with a feed hole at the top. The material was stirred by means of a revolving paddle-scraper. They held about two to two and a half tons at a batch. The drying time was nominally eight hours, but often it was nearer twenty-four hours before the material was dry enough. The Grimsby Manure and Oil Co. operated a battery of twenty-four of these dryers. But there was a good deal of manhandling in this type of equipment and the fact that it operated on the batch principle was a further objection.

In the United States, rotary flame dryers had been in use for some time for drying the press cake obtained after removing oil from fatty fish after cooking. A few of this type of dryer, which was continuous in operation, were also being used in Britain. The Grimsby Manure and Oil Co. had one in operation in 1909, which they knew as 'the American dryer' although it had been made in England. The fish, etc. was 'processed' by cooking under a steam pressure of about 40 lb. per sq. in. for two to two and a half hours, until it was of the consistency of porridge, and had a much greater bulk density than the original material. This was then transferred to the dryer, where it was dried in about twenty minutes. Sometimes the product came out of the dryer scorched, but mostly it appeared to be in reasonably good condition. There was a similar plant in Hull and another at Cove.

All the production of these factories was being used as manure for direct application to the land. Hence its name—'fish manure' or sometimes 'fish guano'. It was sold on its 'ammonia value', although since it contained fish bones, it was also quite rich in calcium and phosphorus (nearly 20 per cent expressed as calcium phosphate).

Fish manure production came under the category of offensive trades. At Grimsby, although the Manure and Oil Co.'s factory was on the outskirts, the exhaust vapours drifted over the town when the wind was in that direction. As a result of complaints from the inhabitants, the Corporation Sanitary Authority took action and obtained a court injunction proscribing manufacture. The company thereupon started up a factory some miles away at South Killingholme. Even in the country there was trouble over the smell, because it was only five miles away from the Earl of Yarborough's estate at Brocklesby Hall. This case came before the court at Barton-on-Humber and the Company won it, but were advised to be careful. In the evidence it was stated by the schoolmaster at Habrough that the 'smell' emanating from the factory was of a certain width, measured in the distance between telegraph poles along the road from Habrough to Immingham. To check upon subsequent complaints, Mr. Richardson took the hint and installed wind direction recorders at Killingholme, a precaution which proved its value on future occasions.

It was rumoured that at German fish manure factories, the noxious fumes were removed by passing the exhaust gases through a bed of peat moss. At Killingholme, therefore, the fumes were first of all passed through a counterflow water condensing tower, 20 ft. high and packed with coke, and then by a series of underground tunnels through a bed of peat moss. After a time the peat got completely waterlogged. It could then either be dried or dug into the ground, since it was quite a valuable manure. In view of the proximity of Killingholme to the Crowle peat moss, it could easily be replaced, so it was dug into the ground. Cove, of course, was practically on top of peat.

It was the continuous, American type, dryers which were responsible for the worst smell. The exhaust from the concentrators was much less odoriferous, for one thing because their rate of throughput was so much smaller, e.g. two and a half tons per eight to twenty-four hours, compared with one ton per hour for the continuous type. It was possible to remove most of the smell from the concentrator vapours by blowing them through a furnace at above 1,000° C. There are still a few of the American type of dryer in occasional use in Britain.

Improved types of dryer were developed,[5] which in great measure reduced the 'nuisance', in particular the German 'Schlotterhose', continuous, steam-jacketed dryer, in which the drying time is only two to two and a half hours. This dryer, which consists of a series of, usually three, U-shaped tubes through which the cooked fish is propelled, was introduced into this country first at Aberdeen at the Mutual Fish Products some time in the nineteen-twenties. The fumes from this were passed through efficient water condensers and then either led into a furnace or else treated with chlorine gas. This type of plant, at first made under licence in this country, with various modifications, including complete steam jacketing instead of the U-shape, still holds the field against most of its rivals. The most recent development is a type of 'air-lift dryer', which has made its appearance in the United States, where flame dryers are still common, and South Africa, where the fish meal and oil industry is of very recent origin. There are already two dryers of this new type in Britain.

With the Schlotterhose dryer it therefore became possible to operate fish-meal plants in close proximity to towns again, although sanitary authorities continued to be strict. Even when led into a boiler chimney the vapours did not always disperse, but came down again on to the town. At some places there were regulations about using the American dryer only when the weather was suitable, for example when the wind was blowing the exhaust vapours over the river or out to sea. At other times only concentrators could be used. At Aberdeen, where regulations are particularly strict, offal may not be kept at the factory for more than twenty-four hours before it is 'processed', although up to thirty-six hours is permitted at week-ends.

About 1905, the demand for fish meal from the Continent, particularly Germany, directed the attention of the managers of factories at British fishing ports to this new outlet, and fish meal began to be exported on a large scale. In 1913, out of a total British production of some 40,000 tons of white fish meal, 30,000 tons were exported to the Continent, the greater part to Germany.

Fish 'fertilizers' were also exported to Japan and to the cotton states of the southern part of the United States, through the medium of brokers in Glasgow and London. However, reports became current that fish manure was being used in Germany for animal feeding purposes. Considerable quantities of the product were sold through Hamburg. Mr. Richardson recounts that in 1911 or 1912 an inquiry was received from Bremen just as he was about to make a business trip to Hamburg. On visiting the inquirer he noticed prize cards for pigs and poultry round the walls, suggesting that he was in fact using 'fish meal', as he called it, as a feeding stuff. With this possibility in mind, Mr. Richardson mentioned what he thought was rather a high figure as the price for his 'meal' which, somewhat to his surprise, was accepted. The Hamburg broker, originally a Welshman but then a naturalized German, refused to buy at the new price and subsequently levelled an accusation of stealing his customers, although eventually accepting the figure.

The Hull Fish Meal and Oil Co. was also active and had an agent in Germany, so that no doubt Mr. Richardson's experiences were typical of those of others in the field at that time.

Then came the problem of inducing British farmers to use fish manure as an animal feeding stuff. Mr. Richardson advertised free samples for the price of the postage. He inquired the names of the corn merchants of those who took up his offer. He toured these merchants on a motor bicycle offering them free advertisements in local newspapers if they would stock his 'Nitrophos' brand fish meal. At about the same time the Scientific Poultry Breeders' Association had been formed, the secretary of which was a Mr. Tom Newman. It took over an advertising journal produced by Hebdich of Plymouth for the purpose of advertising his poultry houses, and rechristened it 'Eggs'. Mr. Richardson joined the Association in order to get a list of names of its members, whom he then proceeded to circularize. At the same time he contacted the expert breeders, such as Burne Murdoch who specialized in Black Leghorns, and gave advice on feeding problems, and Palmer, who was a farmer and wrote articles on feeding problems in a predecessor of the *Farmers Weekly* under the pen-name 'Leics', no doubt on account of his holding at Hinckley. He succeeded in interesting them in the use of fish meal for animals and in this way a market was developed in Britain, although a large part of the production was still exported.

There was a good deal of haziness as to how to use fish meal as a feeding-stuff, and Mr. Richardson used to advise a maximum of 10 per cent in the diet. Various analytical chemists were called in to give advice on formulae. Indiscriminate use led to the product developing a 'fishy' flavour. For this reason it was particularly difficult to make headway amongst the pig-keepers. The National Butchers' Association was against the use of fish meal, and issued a circular to all members warning them not to buy pigs that had been fed on it. Mr. Richardson induced Russell and Sons, bacon exporters, of Cork, to carry out a controlled experiment on similar pens of young pigs fed according to his instructions on fish meal supplied gratis, and good results were reported at killing time. Nevertheless, they still did not purchase any fish meal for fear of fishy taint. However, the first World War interrupted supplies of imported proteins and thus led to a change in attitude. In 1916, the Scottish manufacturers petitioned the Board of Agriculture to use its influence in making known the possibilities of fish meal to the farmer, without much result. Soon afterwards, it was decided to establish a National Association of Fish Meal Manufacturers, having as its primary object making known the value of fish meal as an ingredient of animal feeding stuffs. After the War, with the development of a more scientific attitude to nutrition, coupled with scientifically controlled feeding experiments, the true value of fish meal on the farm began to be properly appreciated. As a result, there was a guaranteed home market for all home production. Together with the increase in landings at Hull and Grimsby from distant fishing grounds soon after the first World War and the growth of the practice of filleting fish at the ports in the mid-'twenties, this led to an increased production of fish meal and the demand for improved, mechanized methods of production.

The United Kingdom now produces about 60,000 to 70,000 tons of white fish meal a year (75,000 tons in 1951) and could probably use over twice as much. Large amounts are also imported from Norway, as well as some from South Africa, etc.

There have even been recently attempts to install fish meal plant on trawlers, for dealing with the viscera and offal discarded at sea. This does not appear to have met with success, owing partly to the excessive oil content of the product, derived chiefly from the livers of small unwanted whole fish.

In the United Kingdom, there was very little manufacture of herring meal and oil prior to 1946, when the Herring Industry Board started encouraging the treatment of surplus herring in this way in order to maintain the catch at the highest possible level to satisfy all other outlets, and at the same time provide some edible oils which were then scarce. Recently, an increasing proportion of the British herring catch of some 200,000 tons per annum has been treated in this way. The precise figures were in 1950 35,600 tons of herring, 1,000 tons of mackerel and pilchards, and 2,750 tons of offal, converted into oil and meal. In 1951, the figures were somewhat lower, 23,000 tons of herring, 2,500 tons of mackerel and pilchards, and just over 2,000 tons of offal. In 1952, however, there was an increase again to over 30 per cent of the catch, and in 1953 to 45 per cent, oil and meal now providing the greatest single outlet for herring, and approaching in magnitude the total British home consumption as human food.[6] In factories at Fraserburgh and Bressay in the Shetland Islands this is processed by the method of cooking and screw pressing, followed by drying in oil-fired rotary drum dryers, similar to the methods chiefly employed in the United States and Norway, where reduction of herring and similar fatty species is a major industry. A large amount of the presscake, however, is dried in the Schlotterhose type of plant, as for instance at Hull, and at a new factory built by the Herring Industry Board at Great Yarmouth.[7]

NORTH AMERICAN INDUSTRY TO-DAY

In the United States and Canada, not only is fish meal and oil production on a larger scale than in Great Britain, but in addition the capacity of the individual unit machines is usually much greater, amounting in an average continuous plant to fifteen to twenty tons per hour. On the Pacific coast, the commonest raw material is fatty fish, such as pilchards (sardines) in California, and herring and salmon cannery offal in British Columbia and Alaska. On the Atlantic coast, menhaden and cannery offal from herrings and mackerel are used and also oily filleting waste from rosefish in the Canadian Maritime Provinces and New England.

In a typical plant, the fish is first cooked with steam at atmospheric or low pressure in a U-shaped trough or cylindrical tube, provided internally with a conveyor worm. The cooking time which varies from fifteen to twenty minutes is often quite critical for a particular species of fish or freshness of raw material. Over-cooking results in loss of protein in press liquors, and bad emulsions, whilst under-cooked fish will not yield enough of its oil on pressing. The cooking liquor is strained to recover solid protein, and the cooked fish is fed by gravity into a screw press of the expeller type, in which pressure is exerted between the propelling worm and the casing. The latter is perforated to permit escape of press liquor, which is led to settling tanks and centrifuges to separate the oil. The press cake, which contains about 50 per cent of water and 5 per cent of oil, is dried in various types of dryer. The commonest is still the rotating, inclined cylinder, using either direct 'flue gases' in a 'flame dryer', burning either oil or natural gas, which dries the wet material without scorching in five to fifteen minutes; or else the fish is tumbled about amongst pipes heated either by flue gases or steam under a pressure of 30 to 40 lb. per sq. in., the drying time being from forty minutes up to three hours in various models.[8]

White fish filleting offal on the Atlantic coast is often dried in steam-jacketed cylinders provided with agitating paddles, sometimes with a steam-heated shaft. These batch plants are sometimes operated under vacuum in order to yield a meal of improved feeding value, because less destruction of essential amino-acids in the protein occurs at the reduced temperatures obtained under vacuum. Continuous rotary steam tube and flame dryers are also used after reducing the moisture content by cooking and partial drying in steam-jacketed vacuum cookers so that the material does not stick to the heating surfaces. Cooking and pressing as for oily offal requires special presses to withstand damage from large pieces of bone. Roller presses and basket centrifuges are used in some plants to 'dewater' the cooked offal.

THE WORLD FISH MEAL SITUATION

It is only the countries bordering on the southern North Sea that eat most of their catch of herrings in one form or another. By far the overwhelming proportion of the world's production of pelagic fish, of which the herring is typical, is caught for conversion into fish meal and oil.[9] The annual pre-1939 world production of fish meal was about 1,200,000 tons, equivalent to six to seven million tons landed weight or about one-third of the world's fish.[10] Only a small proportion of this was made from the head, bones, and adhering flesh of 'white' fish, after filleting, or from surplus or condemned 'white' fish. Most of the meal, together with large quantities of oil, was made from pelagic fatty fish. The average annual production of fish oil between 1935 and 1939 was 460,000 tons (cf. 585,000 tons of whale oil). Japan, together with Korea, Formosa, and Sakhalin, produced about 750,000 tons of meal, which was about two-thirds of the world output and accounted for the major portion of their huge catch. This enormous quantity, the product of some 6,000 small plants, was apparently used mostly as a nitrogenous fertilizer.

After an intermission due to the war, production in the major producing countries is shown by recent statistics to be on the upgrade, with the possible exception of Japan, where they are now eating the bulk of their fish. The world production of fish oil in 1949 was estimated to be 292,000 tons (cf. 392,000 tons of whale oil). The United States, which in 1940 produced 127,000 tons of fish meal and imported 39,000 tons, was already by 1948 producing 120,000 tons of meal, chiefly from pilchard and menhaden, together with 50,000 tons of oil. The figures for 1953 were nearly 220,000 tons of meal and 100,000 tons of oil. Canada in 1948 was producing 30,000 tons of meal and 12,000 tons of oil, and Iceland 20,000 tons each of meal and oil. Norway has recently been catching about a million tons of herring annually, of which about 85 per cent is converted into fish meal and oil, producing about 150,000 tons of meal and 50,000 tons of oil.

The United States also imports large quantities of fish meal from countries such as South Africa, and South West Africa where the catch of pilchards and maasbankers has increased enormously within the last few years from 7,500 tons in 1943–4 to 543,000 in 1951 and nearer 800,000 tons more recently, most of which is used for fish meal and oil. In Angola, too, production is soaring and in 1951 nearly 20,000 tons of fish meal were produced of which nearly 18,000 tons were exported to the U.S.A.

These fish meal and oil products come from relatively up-to-date, highly mechanized industries, that afford the chief, if not in some cases the only, outlet for the large-scale commercial fisheries which supply them with raw material. Only a proportion of the oil is hardened by hydrogenation for the production of edible fat, much being used in industry. Although most of the meal is used as animal feeding stuff, a certain amount, e.g. of menhaden, is still used as fertilizer.

In spite of their large imports, it has recently been estimated that the United States poultry and other animal feeding stuffs industries could use about 375,000 tons of fish meal per year, which would be the equivalent of the entire production of every kind of fish in the United States and Alaska.

RECENT RESEARCH ON NEW PROCESSES

Research and development under way in various countries is aimed at improving both processes and products. The method of cooking and screw-pressing commonly used for fatty fish results in losses in the water effluent estimated at 15 to 20 per cent of the raw material, partly as suspended solids and partly as soluble material, which comprise about 0.75 per cent and 5 per cent respectively of the expressed 'stick-water', i.e. glue water. Steps are now being taken, particularly in the United States, to recover the nutrient and certain accessory factors previously lost. In Norway, too, a whole herring meal is being produced in which there are no losses during processing, and so no 'stick-water' to be added back.

There is also the problem of providing plant to deal as economically as possible with a fluctuating and usually seasonal supply. In the large United States and South African pilchard reduction industries, there is no attempt made to solve it. Plant and labour are provided on a scale sufficient to cope with any likely supply of raw material within a day after landing. To avoid or minimize the uneconomic provision of processing plant, some way of satisfactorily storing the raw material for considerable periods is essential. In Norway, raw fish surplus to processing capacity is simply stored in the open in large quantities, sometimes for months, with insufficient preservative (chiefly salt) to avoid what would in this country be regarded as creating a public nuisance.

A method of storing the fish in unobjectionable fashion by the use of dilute alkali and of subsequently extracting high grade oil has been tried in Britain at Wick on an experimental factory scale.[11] However, although the yield of oil is higher than in the 'cook-and-press' process, the protein products recovered from the alkali liquor are of low grade and less valuable in feeding value than fish meal, and now that the world's fat situation is easier than it was immediately after the war, and fish meal is increasingly important, the alkali process has become uneconomic. Formaldehyde has also been used as a preservative for herrings and for white fish viscera prior to processing, and the resultant product has been fed satisfactorily to animals.[12] Liquid ensilage of fish for animal feeding stuffs, using various acids, has also been tried[13,14] particularly in Scandinavia.[15]

It is obviously more efficient and more desirable to use fish directly as human food than to reduce it to animal or plant feeding stuffs. The menhaden is a case in point. Now almost entirely converted into fish meal and oil, a recent United States review[16] points out that 'Another use for menhaden in the eighteen-seventies, now discarded almost entirely and quite unwarrantedly, was for human food. It seems strange, but menhaden were once considered very good eating when strictly fresh-caught . . . The large fat fish were preferred and were utilized pan-fried, salted, canned in oil like sardines ("shadines") or put up in vinegar and spice like herring. Considerable quantities were also salted in barrels for home consumption and for export to the West Indies. Of course, revival of interest in menhaden as a food fish would run counter to a prejudice built up over many years . . . Some effort in developing food usage might be justified.' The figures given suggest that resources of pelagic fish (i.e. surface-swimming, migratory, fatty species) could be much more efficiently utilized, too much being treated as surplus to direct human feeding requirements. Serious thought should clearly be given to the possibilities of providing in all fishing countries more plant for high-grade processing and storage of fish, preferably for direct consumption either at home or abroad, or alternatively for greater production of animal feeding-stuffs, in preference to using high-grade protein as a source of nitrogen for crops. This would obviously involve great capital expenditure; and there are the additional difficulties in the development of new food habits.

On the other hand, it is generally accepted that, over large areas of the globe, probably the majority of the inhabitants are suffering in varying degrees from malnutrition and particularly from deficiencies in protein intake. In some areas fish meal itself has been considered as human food. From time to time attempts have been made to produce improved dried products more suitable for human consumption.

DEHYDRATION

Modern dehydration methods under controlled conditions attempt to yield a dried fish product which keeps in good condition for a long time and on reconstitution with water is comparable with fresh fish.[24] The first of these requirements has been met, but with regard to the latter, there are still a large number of biochemical problems to be solved. Such processes as have already been worked out involve machinery on a scale comparable with canning. Hitherto, however, there have been no definite signs of any of these becoming firmly established.

There are patents for the dehydration of vegetables dating back to 1840. The products were chiefly intended for use at sea, but were not popular. A process of dehydrating fish was first patented in the United States in 1877, but nothing much seems to have come of it, although a factory is reported to have been established in Gloucester by 'New York parties' in 1880 for the manufacture of this 'evaporated fresh cod fish'.[1] A firm in Wick in the north of Scotland is said to have dehydrated fish during the South African War. Dehydration was taken up again in the United States, Great Britain, and Germany during or just after the first World War and a further attempt was made during and after the last war, but there have still been no real industrial developments.[17]

Dehydrated fish was produced from most British species by air-drying the cooked minced flesh, with or without smoking, and storing in hermetically sealed tins with nitrogen, when it remained edible for six months to two years at tropical and temperate temperatures respectively.[18,19] During war-time, about one hundred tons of herring were dehydrated on a pilot factory scale for use by the armed forces. The product, which could be used only in made-up dishes, such as fish cakes, pies, kedgerees, etc., received a mixed, though fairly encouraging, reception by consumers accustomed to fish in its more usual form.

Generally speaking, the product is cheaper than, but inferior to, canned fish. Except under emergency conditions, when reduction in bulk becomes of primary importance in the storage and transport of foodstuffs, dehydrated fish is not likely to be welcomed in this or other highly developed countries. 'Freeze drying', not yet developed on a commercial scale, yields a product with cooked minced fish that is vastly superior to any dried fish ever produced—one that is indeed scarcely distinguishable from fresh cooked fish.

Dehydration of fish on a pilot scale was developed in Britain during the 1939–45 war, largely with an eye to the possibility of supplementing our own diminished supplies of fresh fish. It therefore aimed at a high quality product, that would be comparable in dishes with fresh fish. The drying of cooked, minced, fish flesh was adopted because it yielded a product which reconstituted tolerably well, whereas whole fish or pieces of fish were very tough when reconstituted, in comparison with fresh fish, although not with traditionally dried and salted fish. The process, and therefore the product, was, however, relatively expensive.

Another process which has been experimented with in Denmark, Norway and, at present, in Britain, is the vacuum drying of whole fillets of fish between heated plates.[20] The dried product is subsequently sawn to a suitable shape and compressed into blocks, hence the name 'Pressfish'. Obviously if fish dried by this method can be reconstituted in such a manner as to be comparable in appearance, flavour and texture with a piece of fresh fish, it will be immensely superior to the dried, minced, cooked product.

On the other hand, working from the other end of the scale, it would be possible to improve fish meal as it is now known. Much of the protein value of fish meal is due to the flesh adhering to the head and bones from which it is made. Methods have been devised from time to time for removing this flesh and subsequently drying it with a view to its use in fish cake mixtures, etc., for the home market and for export to markets in need of a cheap form of animal protein.

THE PRESERVATION OF FISH FOR TROPICAL COUNTRIES

The efforts of the more highly developed countries will be increasingly directed in the foreseeable future towards assisting to raise the standards of living of the less developed countries of the world, in Asia, Africa, and South America. This can be done by improving present native practices and processes of handling and preserving fish (*already referred to on p.* 183 *et seq.*) and by the utilization of surplus European, American, and Japanese fish for the preparation of products acceptable to the peoples concerned.

Native practices of fish preservation and consumption have in all probability not been unaffected by the impact of the relatively recent contact with Europeans. The large import of Norwegian stockfish into Nigeria is a case in point. There is perhaps no reason to be unduly pessimistic about native conservatism in accepting new products, although, of course, caution and discretion must always be exercised in introducing new commodities.

In many, though not all, parts of warm countries, the natural difficulties encountered, high temperatures and humidities, and pest infestation, are severe. Experiment has shown how important it is in such conditions to eviscerate, bleed, and wash the catch thoroughly at the earliest possible opportunity prior to curing. The coastal production of ice and its use in fishing boats would provide a still more important improvement, ensuring a good start to the chain of processing and distribution. Another way of improvement would lie in the provision of higher grade salts for curing, i.e. salts containing much less calcium, magnesium, and carbonates, the presence of which in various ways renders preservation less speedy and sure.

In many British and French Colonies, the Philippines,[21] Sudan, etc., attempts are being made to improve existing methods of fish preservation and to develop new ones. But the nutritional level is in many cases so low that it is not to be wondered at that where fish is used in minute amounts as a condiment, or flavouring, an obvious, even if putrid, flavour is welcome to impart some character to an otherwise drab cereal dish. As the nutritional level is raised by increased home production or imports of fish, it is more than likely that products more resembling those developed in feudal Europe will come to be preferred.

That the great difficulties faced in warm countries may be surmounted successfully and a technique developed which will make possible the distribution of fish over a large area and the spreading of a seasonal supply over many months is exemplified by experiments conducted recently in the Gold Coast.[22] 'Buffer' storage for some months prior to curing was achieved by salting in brine in tanks. Curing then consisted of partial desalting, partial sun-drying, and finally hot smoking. The products, which were perfectly sweet, although rather brittle compared with those cured without preliminary storage, were suitable for transport up country when well packed in cases, and had a storage life of some three months.

Much further research is still urgently needed, however, in this general field. More information is required about the composition of tropical fishes; the keeping quality of 'wet' fish under given conditions, particularly of temperature and of handling and stowage; the storage life of cures; the insulating properties and durability of locally made fish containers; and finally about the possibilities of simple mechanical apparatus for controlling drying and smoking and for the extraction of by-products.

The existence of large surpluses of fatty fish throughout the world which are largely utilized for the manufacture of animal feeding meal and oil, has already been discussed. If these fish could be preserved in some suitable form at a low cost, it is quite likely that they would be accepted in many of the areas of the world which at present experience a chronic deficiency of animal protein. Most of the processes for fish meal manufacture discussed in the earlier part of this chapter could be suitably adapted for the purpose of producing an edible meal. Markets for existing or entirely new herring products from British herring might thus be found in Africa and Asia to replace those lost in Europe, where people of other countries are now either losing their liking for salty products or supplying their own requirements. New products will almost certainly present some problems of acceptability in under-developed areas, which may have to be overcome by the development of new food habits, as they must have been from time to time in the past. Enquiries suggest that practically any type of product that could be made would be regarded as acceptable somewhere in the world. Thus a form of smoked 'red' herring is being experimented with by Norway for the African market. South Africa has recently been salting and drying a species, *Merluccius capensis*, which they call 'stockfish', and which is similar to our hake (*Merluccius vulgaris*), for consumption in Africa. However, salted fish is not always readily accepted, at least in some parts of British West Africa, although salt itself is a necessity. It is possible that some sort of 'herring stockfish', with a smoking similar to the bonga would be quite acceptable.

The problem of exporting canned fish as cheaply as possible to the protein-starved areas of the world, or, where possible, of developing local canning industries, equally calls for sustained effort. West African species have already been satisfactorily canned. The trade that Japan has established in cheap canned fish products with various parts of Africa is, perhaps, a pointer to the future. For example, minced packs from which liquor, mostly water, has been expressed after cooking, thus making the fullest use of tinplate, might well prove acceptable to races accustomed to incorporating what animal protein they can acquire in hashes and stews.

Although evolved to meet specific war-time needs, dehydration is also capable of being adapted, if required, to mass satisfaction of the needs of the peoples of those parts of the world where protein deficiency is chronic. Perhaps herein lies its best chance of successful development.

During war-time small samples of dehydrated herring were sent to various tropical countries and drew favourable comments. Even dehydrated whole herring, which yields a 75 per cent larger output than fillets, was if anything preferred for its extra flavour.

An official report on the sea fisheries of the British colony of Sierra Leone[23] gives a detailed account of trials of the acceptability of experimental samples of cod and herring dehydrated at Torry Research Station in 1943. 'Small amounts of the dehydrated fish provided were given to representatives of the different classes of workers of Freetown, with a view to obtaining, as far as possible, a good cross-section of public opinion as to the usefulness and popularity of such a new foodstuff . . .' In all cases the verdict was in favour of the sale of dehydrated fish as a useful addition to the African diet.

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Chapter 14

THE FUTURE

PRESERVATION TO-DAY

Before considering possible future trends it is instructive to examine the types of fish preservation methods at present in use throughout the world, and their relative preponderance and distribution (*see* Table 5).[1] It is fortunate that the Food and Agriculture Organization of the United Nations (F.A.O.) is now systematically compiling and publishing statistics which for the first time make such a world picture a practicable proposition.[2] Of a total world production of approximately 26 million tons, half of which is caught and consumed locally in Asia, about 82 per cent is produced from the sea, chiefly the Atlantic (N.E. 22 per cent, N.W. 10 per cent), Pacific (N.W. 24 per cent, N.E. 3 per cent), Arctic (3 per cent) and Indo-Pacific waters (10 per cent), and the rest comes from inland waters. Some 45 per cent of the total is consumed in the fresh state and mostly enters into domestic consumption. Curing, by drying, salting, smoking, marinating, etc. to produce a wide diversity of commodities absorbs about one-third, consumed predominantly in Asia, southern, central and eastern Europe, Belgian Congo and Brazil. Canning, which takes 6.6 per cent, is of major importance in North America and of lesser importance, although well established in Europe, Asia and the U.S.S.R. Freezing, although a major and growing section of the industry in North America and increasing in Europe, only accounts for 3.5 per cent of the world catch. Reduction to oil and animal feeding meal, which has grown considerably during the past decade, now takes more than 10 per cent of all fish, including nearly one-half of the herring and similar species, and accounts for one-third of the African catch and one-fifth of the catch of Europe and North America, although so far as is known very little in U.S.S.R.

Although because of its perishability the bulk of world fish supplies has always been, and still is, absorbed by domestic consumption, developments in preservation and transport have

TABLE 5. APPROXIMATE WORLD DISTRIBUTION AND UTILIZATION OF FISH IN 1951

(*thousands of tons*)

Country	Total Catch	Cod etc.	Herring etc.	Con-sumed Fresh	Frozen	Cured	Canned	Reduced to Oil and Meal	Production of Oil and Meal					
									Her-ring etc. Oil	Her-ring etc. Meal	Other fish Meal	Cod Liver Oil	Whale Oil	Whale Meal
Denmark	292	51	31	124	27	16	13	88	4	12	8			
Faroes	93													
France	463	97	98	282		132	48	2			8	2		
Germany	680	188	317								54			
Iceland	418	225	85	68	118	105		127	11	10	29	8		
Italy	184		65											
Netherlands	280	21	150	103	7	118	13	28			10			
Norway	1,819	486	1,205	145	65	509	58	1,023	80	170	17	16	196	5
Portugal	308	134	82											
Spain	592	184	131											
Sweden	200	48	107											
United Kingdom	1,086	734	180	791	33	170	20	74	2		77	15	83	13
Total—Europe	6,000	2,200	2,100	2,800	200	1,500	200	1,200						
U.S.S.R.	2,500	200	600	1,200		1,000	200						31	1
China	3,000													
India	763													

Indo China	450													
Japan	3,800	211	852	1,690	106	1,287	96	255	3	20	35	1	34	
Korea (S.)	276													
Malaya and Singapore	177													
Philippines	296													
Total—Asia	12,000	300	2,000	5,800	100	5,000	200	400						
Canada	670	158	272	149	107	119	107	156	16	32	18	5		
Newfoundland	321	239	29	11	54	221		13						
U.S.A.	2,345	195	740	740	313	43	648	565	55	129	51			
Total—N. America	3,800	600	1,300	1,100	500	500	900	800						
Chile	93	42		50				27						
Total—S. America	500			300		100	100							
Angola	140													
French Morocco	91													
South Africa	350													
S.W. Africa	140													
Total—Africa	900	100	400	300		200	100	300						
Oceania	200			100										
World Total	26,000	3,400	6,400	11,600	900	8.300	1,700	2,700	186	428	316	47	503	26

TABLE 6. INTERNATIONAL TRADE IN FISH AND FISHERY PRODUCTS

(*thousands of tons*)

COUNTRY	Total		Fresh and Frozen		CURED						CANNED				Oils		Fish Meals	
					Total		Cod etc.		Herring etc.		Total		Herring etc.					
	Ex-ports	Im-ports	Ex-ports	Im-ports	Ex-ports	Im-ports	Ex-ports	Im-ports	Ex-ports	Im-ports	Ex-ports	Im-ports	Ex-ports	Im-ports	Ex-ports	Im-ports	Ex-ports	Im-ports
Denmark	126	53	91	17	11	11	10				3			24	4			
Faroes	45				42											8		
France	29	92	14	17		7						30		24				
Greece	29						13											
Iceland	208		89		58		37		17						21		36	
Italy		123		21		72		63		8		18				10		
Netherlands	144	89	17		57		56				8				20	49	3	32
Norway	630	26	126		164		72		81		32		28		161	21	131	
Portugal	38	24				22		22			27		23					
Sweden	58	56	36		15	22			14	19					10	26		
United Kingdom	75	465	10	158	42	6	6	6	31		13	23	10		11	*170		100
West Germany	21	294		85		21				20		5				143		32
Europe			380	351	351	192					88	93			244	458	174	182
Ceylon		43				37												
China		11																
Indonesia	25	54				30						20		18				

India	20	5																
Japan	78	1	23		4						23							
Malaya	47	99			33	42					9	23		13				26
Philippines	47											40		36				
Thailand	21	3			20													
Asia			31	12	66	120					23	97			9		9	31
Canada	315	39	115		95		68		22		21		6		11		48	
Mexico	90		69															
Newfoundland	110		14		79												5	
U.S.A.	127	448		169		46		25		18	67	27	59	14	23	39	30	118
N. America			186	174	96	48					88	31			40	40	78	119
Brazil		26						20										
S. America						26					10							
Angola	52				15												31	
Belgian Congo	25					24						4						
French Morocco	57										40		39				10	
Nigeria		10				8												
South Africa	50	9			8						10					5	19	
S.W. Africa	35															5	23	
Africa			12	8	33	53					62	26			17	6	83	
World Total			613	545	546	412	261	248	320	504	344	332	214	133	226	100	182	140
No. of Countries			42	37	46	62	30	64	27	33	23	18	13	27	18	21	17	32

*153 Whale Oil

gradually facilitated a wider distribution, so that now some 20 per cent of the world catch enters international trade (*see* Table 6), mostly by more or less local exchange, but with an increasing proportion of inter-continental traffic.

Norway now supplies more fish products to the world market than any other country, with Canada a poor second, and Iceland some way behind, followed by the Netherlands and Denmark. Angola, South West Africa and the Union of South Africa constitute a bloc which is sending abroad shipments totalling about the same as each of this last pair of North Sea countries. However, of course, the gross amounts are hardly to be compared in this way owing to the high proportion of fish meal and oil in the exports of Norway and these African countries.

Norway is again the heaviest exporter of cured fish, consisting of cod and herrings in about equal quantities; the chief markets being Brazil, Russia and Germany respectively. Canada once more takes second place with Iceland next, both mostly dealing with salt cod, and the Netherlands is not far behind with herring. Thailand and Malaya, including Singapore, all on the Gulf of Siam, together export nearly as much cured fish as either of the latter two countries, although after a rapid post-war recovery they have not yet reached their pre-war level. Angola exports as much as Sweden.

Norway again provides the largest single quantity of fresh and frozen fish on the world market, two-thirds of which is accounted for by herring and sprats, followed closely by Canada. The United States and Japan, although heavy producers consume most of their frozen fish at home. Britain is a heavy importer of fresh fish from Norway, Denmark, and Iceland. The United States imports frozen fillets from Iceland, and fresh fish from Canada and Mexico.

In canned fish, the United States is the biggest exporter, mostly in sardines and pilchards, about half of which go to the Philippines. French Morocco is the second exporter, almost entirely of sardines, nearly half of which go to France. Norway and Portugal also export sardines, sprats, etc., Japan tuna and Canada canned salmon, mainly to Britain and the United States, and sardines to the West Indies, Malaya and the United States again. Norway, the United States, Iceland and Canada produce four-fifths of the fish oils, mostly herring and similar oils with cod liver oil second. Most of this production and chiefly the Norwegian ends up in western Europe, although the United States also imports a fair quantity. Britain imports 170,000 tons of whale oil, 100,000 tons of which is taken from her own whalers. Germany is thus really the greatest single importer of marine oils.

Of the fish meal production chiefly in the United States, Norway, the United Kingdom and South Africa, Norway is the biggest exporter, more than half going to Britain and the rest chiefly to Germany and the United States. Canada's exports go almost entirely to the United States. Iceland's production, once made chiefly from herring but more recently produced largely from 'rose-fish' (*Sebastes*) and saithe, etc., goes largely to the Netherlands and also to United States and Germany. The Union of South Africa, like the United States and Britain, now uses most of its fish meal at home, but along with Angola and South West Africa exports twice as much as Iceland.

THE PROSPECT BEFORE US

At most times in history it must have seemed to the participants that progress was infinitesimally slow. Nevertheless, the telescoping of significant events provided by a backward glance indicates that there was steady, inexorable progress even when the pattern may have appeared most static. And then regularly, at intervals, at the end of periods of relatively slow development, when conditions are ripe, and energies are released, there are comparatively sudden bursts of development when techniques are in a state of flux until they settle down again to a further period of slower maturation.

From time to time there have been local difficulties and recessions which hinder smooth development, but history provides us with no grounds for thinking these are other than temporary or epiphenomenal. Nor is there any reason for the belief that all development is now at an end. In fact, when the world is looked at as a whole, it seems more than likely that so far as fish and fish technology is concerned, we are now at the end of one technological epoch and are about to enter a new phase of rapid transformation.

In Britain just after mid-century with fish appearing to be on a decline in public esteem, we need to consider the situation with particular objectivity. The increasing demand for white fish consequent upon the use of ice, the spread of railways, and the development of trawling has led to relative exhaustion of the nearer waters with the result that fishing grounds have to be sought in areas far distant from the home country, the round trip often taking so long for an economically full load, that the two weeks' maximum 'life' in palatable condition for iced, gutted fish is frequently exceeded.

In the first place, therefore, it must be admitted that people may in fact have 'gone off' fish in recent years, for a variety of reasons, among which are its doubtful freshness, its relative expensiveness, or, in the case of herrings particularly, bones, smell in cooking, and indigestibility owing to the oiliness. Fish too might well be suffering at the present from competition with meat, eggs and bacon, and cheese, now more freely available. In answer to this objection it may be said that, provided it is really fresh, fish, even the commonest cod, can easily compete on equal terms with the alternative foodstuffs, which in any case are themselves not always reliable. Meat is often tough, or rancid through an excessive period of cold storage, imported eggs are sometimes a doubtful proposition, bacon can be too salty or rancid, and so on. Even in the well-known fifteenth century dithyramb in praise of 'good ale', most solid foods are lambasted, the nitrogenous ones among the rest; as thus:—

Bring us in no befe, for there is many bones . . .
Bring us in no bacon, for that is passing fat . . .
Bring us in no mutton, for that is often lene,
Nor bring us in no tripes, for they be seldom clene . . .
Bring us in no eggs, for there are many schelles . . .
Nor bring us in no pigs flesh, for that will make us bores . . .
Bring us in no capons flesh, for that is often dere,
Nor bring us in no dokes flesh, for they slober in the mere.

It is perhaps noteworthy that fish does not appear in this catalogue, although in the above version it would seem to be more appropriate than 'befe'. Fish at least has the advantage of providing clear sensory evidence by its odour when it is 'off colour'.

If fish were always really reliable, instead of having acquired a reputation rather worse than that of any of the above mentioned foodstuffs, it need fear nothing from free competition. Another point in favour of maintaining the consumption of fish so far as Britain is concerned is the fact that it is 'home-produced'. In fact, the annual landings of fish are greater, at one million tons, than the home production of meat, which was 900,000 tons in 1952, with imports amounting to a further 600,000 tons. However, allowance must be made for the greater wastage owing to the higher proportion of inedible material in the case of fish as landed compared with meat as imported, although not perhaps as gross carcass weight. Moreover, even the present level of home production of meat would be impossible without imported feeding stuffs.

It is for these reasons that it is imperative to maintain and increase our consumption of fish which is several times greater *per capita* than that of most comparable industrialized countries, such as the United States, Canada, and Germany. The key to this socially desirable objective lies in improving the average level of quality by better handling to prevent, or minimize, deterioration at all stages of handling and distribution. This realization accounts for the particular priority that is being given to the problems of improving the preservation of the fish that arrives in the least fresh condition from distant fishing grounds, and the efforts being made to develop a practicable process of freezing fish at sea.

Taking a world outlook, the present annual fish catch of some 25 million tons is considered by biologists to be capable of several fold increase. The United Nations Scientific and Cultural Conference on the Utilization of Natural Resources in 1948 listed numerous examples throughout the world of un- or under-exploited species, including herrings in the North Sea.[3]

A British participant comments that on the map it was possible 'to write against every continent except Antarctica, and on both sides of every continent at least one major population of good, healthy, edible fish that we believed to be underfished.'[4] There are at present technical as well as financial and economic barriers in the way of the rational exploitation and distribution of these vast untapped resources.

Obviously the solution of the problems of freezing at sea would mean that these at present inaccessible, or unwanted fish populations could be made available anywhere else in the world by means of refrigerator ships, just as are other surplus food commodities such as wheat, meat, fruit, etc., at present.

There are enormous tracts throughout the world, particularly in Africa, Asia, and South America where there is gross protein deficiency and widespread malnutrition and disease arising therefrom, with appalling losses to child life and to the health of the future generation. At the same time, if present predictions materialize, the world population, at present standing at about 2,500 millions, will have extended to '4,000 million mouths' by the end of the present century. It is obvious that every and any form of protein will have to be fully utilized in human nutrition. Moreover, as the under-developed countries of Africa and Asia inevitably increase their production, skill, and standard of living, they will, in addition to developing their own fisheries to the fullest possible extent, be competing with nations such as our own for the exportable surpluses of the world upon which Britain, as a primarily industrial and non-agricultural country is particularly dependent.

With this threatening shortage in sight, some quite novel types of protein are receiving serious consideration. Among these are the extraction of grass protein for direct consumption without going through the relatively inefficient medium of a farm animal; the cultivation of food yeasts (e.g. *Torula*) on residues from sugar extraction in the West Indies; and the cultivation of certain green algae of the *Chlorella* type.

So far as the sea is concerned, there have been proposals for filtering off plankton (the floating food of fishes, consisting both of green plants—*phytoplankton*—and small animals—*zoöplankton*) and also of harvesting for direct human consumption in some form or other, the krill, or large shrimp-like organism, on which the Antarctic whales feed. This must occur in enormous quantities for such large numbers of whales to exist and build up their huge bodies, of which the equivalent of some million tons or so are captured annually, mainly for the sake of extracting their blubber.

However, all these schemes seem of secondary importance whilst we are still not fully exploiting, or utilizing, and sometimes are even wasting our resources of edible fish.

The fish meal and oil industries of the world which are based on cheap and plentiful pelagic species, such as herrings, are one aspect of the uneven development of the resources of the world leading to an economic inequality in which in one quarter of the globe protein foods can be afforded for conversion into food for animals, which in turn feed us at second remove, while protein deficiency is rife in the other three-quarters.

The possibility of much improved utilization of our existing fish catch, combined with the fact that fish production could, according to a British expert, be 'doubled, trebled or quadrupled . . . makes plankton skimming or throwing fertilizer into the sea look a little foolish.'[4]

The main technical and economic problem of the second half of the present century will undoubtedly be providing a better standard of living, including nutrition, for the under-developed peoples of the world. In view of the present low economic and industrial level of most of the countries of Africa and Asia, the most urgent problem in the early phases of their habilitation will be supplying protein in some cheap and convenient form. This need might well be met by some form of dehydrated fish as described in Chapter 13, or even ordinary fish meal, or something in between which will result in a somewhat more attractive product than the latter, without the cost and labour involved by the former. Although canning results in a product generally regarded as superior even to the best dehydrated fish, it is probably considerably more expensive. Freezing, with its need for a 'cold chain' of refrigerated transport and storage to ensure satisfactory distribution, is even more costly.

It would not be practicable, therefore, to rely to any great extent on either of these more sophisticated processes when breadth of distribution is more important than quality, as judged by western standards. In addition, there is every reason to believe from trials that have been carried out that many native palates may for some time prefer the coarser flavour of fish meal to the rather blander characteristics of canned fish or fish frozen in the fresh state. Moreover, a mealy product can normally be satisfactorily incorporated into the predominantly cereal dish of rice, or millet, or 'mealies', or whatever is current in any particular area, and thus fits conveniently into native dietaries. A 'high' flavour may be acceptable where protein foods are used as condiments to flavour cereal dishes rather than as a source of nitrogen for body building. However, when fish ceases to be merely a flavouring and is plentiful enough to be regarded as a foodstuff, such highly developed flavours as are relished at the present may well become intolerable. In this second phase, the quantity of protein available may be presumed to have become sufficient, and consumers will have begun to be more discriminating as regards quality.

Before the stage is properly set for modern mechanical methods of preservation, such as canning, for these vast new consuming areas, the traditional methods of salting, smoking, and drying, which still account for the bulk of the world's fish and which require little or no machinery by comparison, will in all probability take on a new lease of life. Such methods will still, on a world view, be regarded as anything but 'obsolescent', despite a recent pronouncement to this effect by a United States expert.[5]

On account of the dislike, already mentioned, of salted products in many parts of Africa, more reliance may have to be placed on drying alone, by expanding the range of stockfish imports (*see* p. 174) or on drying combined with smoking to produce, e.g. from herrings, or menhaden, articles similar to the *bonga*, (*see* p. 184).

Ultimately, however, if the last few centuries' experience of the present industrially advanced countries is any guide to the likely trends in taste amongst the less developed countries once they become industrialized, those methods of preservation which result in severe, irreversible alteration of flavour (e.g. 'cured' or salty) and texture (chiefly toughness) will be abandoned in favour of those which yield a milder product more similar to fresh fish.

At this stage, preservation by canning would begin to assume a greater part, probably reaching heights far in excess of present-day peaks, as the world market expands on a colossal scale in response to the needs of Africa, Asia, and South America.

Again, taking Western Europe and North America as a model, since the steam locomotive led to the creation of a network of rapid land communications, the use and manufacture of ice has become the *sine qua non* for the short term storage and transit of chilled fish, allowing a 'life' from catching to consumption of at maximum two weeks in the case of most gutted fish kept at 32° F. Any long-term replacement of the present world preponderance of methods requiring salting, drying and smoking by fresh fish as caught will call for a ten or a hundredfold increase in ice production. In Europe this switch-over occurred over a relatively short period in the middle of last century.

The use of ice to keep fish fresh in warm climates is certain to be attended by great difficulties, and it seems likely that even more so than in temperate climates, artificial refrigeration, and finally freezing will be preferred, as preserving the fish in the condition as caught. Canning by contrast, although providing convenient, ready-to-serve dishes, results in standardized and characteristic, some people might even say, caramelized flavours. Frozen fish can be prepared at the will of the cook. Whereas canning which, although highly mechanical, is a 'once for all' process, requiring no 'after-care', freezing requires continuous processing in the form of cold storage until sale for consumption. It is therefore certain to be expensive of capital equipment and accordingly to be applied on a large scale a stage later than the other processes mentioned. However, nothing is more certain than that as standards of living are increased throughout the world, greater and greater dependence will be placed on freezing, as the method *par excellence*.

The better utilization of the fish resources of the world is being given serious consideration by the Food and Agriculture Organization of the United Nations. An international conference to discuss and stimulate increased utilization of the herring was held in Bergen, Norway, in September, 1950. Special attention is being devoted by a working group following the conference to the possibility of processing surplus north-west European herrings in forms suitable for distribution in tropical areas. It is to be hoped that the outcome will be trials of the acceptability of likely products which, if successful, might ultimately be the basis of large-scale commercial production.

The main factor impeding developments at present, is not so much lack of technological data as economic backwardness with consequent low incomes and poor standards of living. Britain is attempting to produce cheap products to overcome this state of affairs, but as a country she may not be able for various reasons to compete economically in low-price markets. Even herring used for fish meal and oil manufacture has to be subsidized. However, countries such as Norway, or the United States and perhaps South Africa, can produce fish extremely cheaply. It has been estimated that the production cost of Californian pilchards is $\frac{1}{2}$ *c.* per lb. (although this species is already 'overfished' and in danger of extermination) and in the case of menhaden is only $\frac{1}{3}$ *c.* per lb. At these prices dried products acceptable to native populations could probably be produced at something in the region of 6*d.* per lb.

The competing claims of backward peoples and the beasts that feed the advanced races would have to be faced in planning the future long-term strategy of distributing the food resources of the globe amongst its inhabitants. In view of modern enlightenment and technique, there is no reason why Africa and Asia should recapitulate slowly and painfully every step in the sequence of events thrashed out by the more advanced nations. Developments can surely be speeded up and telescoped and several different phases proceeded with concurrently. In fact, already there is a wide range in the degree of development amongst the countries grouped together for convenience as Africa and Asia, and as some of these nations begin to forge ahead on their own, some of these differences in status may be expected for a period to widen rather than narrow.

It may be concluded from the foregoing considerations that there are ample problems to keep food technologists fully occupied in planning and securing the optimum utilization of the fish resources of the world for as far into the future as it is profitable to speculate.

Finally, if it is accepted that all development is not necessarily at an end, we have to admit the possibility of new processes arising. Even freezing is not an altogether perfect method of preservation. It causes some irreversible changes which result in slight after-effects, e.g. the formation of 'drip', which permits fresh fish to be distinguished even from first-class thawed, frozen fish, although with some difficulty. These adverse changes are accentuated by prolonged cold storage even at the lowest temperatures at present economically feasible. Finally the need for an elaborate 'cold chain' is itself a burden.

In recent years the possibility has emerged of a process which may conceivably overcome these disadvantages and provide a product in a closed container which retains the quality of the fresh fish but can be stored at temperatures above freezing—even at room temperature. This promise is one of the outcomes of research work on the nature of the structure of atoms which culminated in the unlocking and controlled release of atomic energy, one offshoot of which was the atomic bomb. If a high-power beam of electrons produced in the type of 'atom splitting' apparatus used in nuclear research is passed through a foodstuff under suitable conditions the latter can be 'sterilized', i.e. all the viable bacteria and other micro-organisms can be destroyed. It is also claimed that the non-living enzymes, which would cause foodstuffs to deteriorate even in the absence of bacteria, can be de-activated by a more extensive treatment. The main problem is to give a 'dose' that will destroy micro-organisms and de-activate enzymes without producing chemical side effects which will affect flavour and palatability adversely, and even incur the danger of toxicity. The chemistry of these changes is complex and only partially understood, particularly in systems of high fat or oil content and much remains to be done before they can be brought fully under control. Of course, it will always be necessary to secure such sterilized materials against re-infection by airborne micro-organisms by keeping in a suitable air-tight container during and after irradiation.

The low penetration of the particles hitherto used will probably restrict the product to thicknesses of two or three inches, but the possibility of achieving much greater penetration will appear when the industrial use of atomic energy becomes a reality. Waste radiation in several forms will then become available and could be used near the site of future 'atomic piles', or even in more distant factories.

So far as can be seen at present, with present-day sources of radiation, the cost of first development of such a process would be high, but if the use of the process became widespread the costs would probably come down to a level which would be practical for many products. Experts envisage the cost of sterilization being below ½*d.* per lb. some day, with partial sterilization even cheaper, the main cost being in protecting the food from irradiation damage. Between ten and twenty years has been mentioned as the period that might be expected to elapse before significant quantities of radiation become available. An international decision to ban the manufacture of atomic weapons would release fissionable materials and resources of equipment and scientists which could hasten this amongst other possible peace-time uses of atomic energy.

If we 'dipt into the future, far as human eye can see, Saw the Vision of the world, and all the wonder that would be' it might be that some process based on this possibility, at present a cloud on the horizon, no bigger than the proverbial 'man's hand', would be at some stage a staple method of preservation for the fish food for who knows how many thousand millions of the world's populace. This is a decidedly more pleasant prospect of the atomic future than the one that Tennyson foresaw in the same *Locksley Hall*, already a reality just over a century later, when he:

> Heard the heavens fill with shouting, and there rained a ghastly dew
> From the nation's airy navies.

To quote further, this, like many another peace-time development, may have to await the not-to-be-delayed epoch when:

> The war-drum throbs no longer, and the battle-flags are furl'd,
> In the Parliament of man, the Federation of the world.

Another possibility that arises is that most of our fish, particularly cod with their relative tastelessness, and herring, etc., with their bones and indigestibility, may be unable ultimately to compete with unlimited supplies of fresh meat in perfect condition. In that event, fish meal may indeed be the only outlet for fish, other than a limited few with a particularly delectable flavour, such as halibut and salmon. On the other hand, it may be asked whether the human race will continue always to be carnivorous. Professor J. B. S. Haldane has remarked that the time may come, perhaps in the not-too-distant future—some time after human warfare has subsided—when it will no longer be possible to obtain people willing to slaughter mammals for food. Perhaps fish with its coldness and paucity of blood, may escape this odium for a period, provided people can be induced to go to sea to catch it, if indeed a few centuries of further progress in electronics, etc. has not rendered actual fishing operations unnecessary. Lastly, it may be supposed, this 'loftier race than ere the world hath known' will regard all flesh eating with the horror expressed in George Bernard Shaw's remark about 'charred corpses'. Only then will there be no further work for the fish technologist.

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